



**REPORT OF THE WORKING GROUP
ON
EQUIPMENT AND SCIENTIFIC INSTRUMENTS
OR
EDUCATIONAL INSTITUTIONS**



PLANNING COMMISSION
GOVERNMENT OF INDIA
NEW DELHI
March, 1969

R E P O R T

of



सत्यमेव जयते

The Working Group on Equipment and Scientific Instruments

Government of India
Planning Commission
New Delhi.1.

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Foreword

The Planning Commission set up a Working Group in 1965 to examine the position of scientific equipment and instruments required for various educational institutions up to the end of the Fifth Plan. The Group was also to review the present indigenous capacity for manufacturing these equipments as well as the requirements and procedures of import of essential equipment. The Working Group broke up into a number of committees to consider the requirements of scientific equipment and instruments in schools, universities and colleges, engineering and technological institutions, medical institutions and agricultural colleges and universities.

These committees set up a number of sub-committees, wherever required, so as to draw on the experience of working teachers and experts in their respective fields. The reports of a number of these committees and sub-committees have been finalised. The work, however, could not be completed as the Planning Commission, which was reorganised in 1967, had decided that all previous committees should be disbanded and if necessary new committees might be set up to consider issues which still needed consideration. Since then there has been some further thinking as to the body or bodies which should carry on the work of assessment of the requirements and supply of equipment. In view

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of the fact that the task is stupendous and a very large number of organisations and Ministries have to be involved in it, it was decided to bring together the work that had already been done so as to provide the starting point for the work of the body that might be constituted for carrying forward this work. It is hoped that the general principles discussed in this report as well as the work done by the various committees will provide a useful base line for further work. This report should also be useful to the educational institutions as well as to the manufacturers of various types of equipment. When this work is completed, it should give adequate data to indigenous manufacturers so that they can plan their capacity according to projected demand.

Our thanks are due to Chairmen and the members of the Working Group and the various committees who have helped us in the work of this Group. Our special thanks are due to the Directorate General of Technical Development, whose officers extended their full cooperation to the Working Group and its committees.

D. P. Nayar

D. P. Nayar
Senior Specialist (Education)
and
Secretary, Working Group on
Equipment and Scientific
Instruments.

Summary of recommendations

1. The Working Group stressed that so far as possible India should meet its requirements of equipment and scientific instruments out of indigenous resources and should strive to achieve self-sufficiency in as short time as possible. The indigenous units should be assisted to increase their production capacity. For this purpose, indiscriminate import of scientific instruments by educational institutions should be discouraged.

(Paras 1-4)

2. It was noted that although the instruments industry in India had made considerable progress in the past two decades, their production had continued to remain at a level which could have been improved for higher precision than at present. In a large number of cases the equipment was indigenously available and still the demand for imported equipment was made because of the predilections of research workers to certain brand names and lower prices. It was necessary that an analysis of the imported scientific instruments of the various categories in the past few years may be made by the Ministry of Industrial Development and Company Affairs. Further, the capacities that exist at present for the supply of various types of scientific instruments and the demand position should also be properly worked out.

(Para 9)

3. So far as the sophisticated equipment was concerned, it was felt that a few samples of instruments

and equipments available in various laboratories should be studied carefully with a view to undertaking their design and development for subsequent production and introducing such modifications as might be considered necessary so as to utilise indigenous materials and production capabilities. In the case of strategic materials and components, however, a policy of liberal imports was recommended. It was also necessary to rationalise and standardise the items based on performance requirements and design development so that steps might be taken to produce these items in the country. In view of the limited demands for such items, it would be necessary for the government to provide proper incentives and subsidy both for undertaking design and development and for establishing their production indigenously for the small quantities required from time to time.

(Para 10)

4. Before expanding instruments manufacture in collaboration with foreign manufacturers, there was need for improving the quality of indigenous manufacturing units and standardising their specifications so that the foreign collaborator could take full advantage of the local productive capacity.

(Para 12)

5. It was noted that the equipments from the East European countries were not always of the requisite standard and were also not tropicalised to suit local

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weather conditions. It was felt necessary that the State Trading Corporation should look into these deficiencies before agreeing to import instruments from the East European countries.

(Para 14)

6. The Working Group attached the highest importance to the maintenance of the requisite quality of the scientific instruments. For this purpose it was suggested that a Panel of Experts consisting of the representatives of the educational institutions using the equipment, Ministries of Education and Industry and Supply, industrial units using the equipment, Planning Commission and the Council of Scientific and Industrial Research as well as other concerned organisations should be constituted. The Panel should constantly review the degree of achievement in design and development. It should also screen the lists of equipments and the quality of instruments supplied by various firms and categorise the firms on the basis of the quality of their products. Any defects found during operation should be intimated to the Central organisation which had certified these firms. Genuine complaints should be made public as a guidance and warning to the manufacturers and as information to the users.

(Para 15)

7. Repair and servicing facilities should be strengthened and dispersed in different regions of the country.

(Para 17)

8. The educational institutions should be encouraged to fabricate their own equipment. For this purpose, the teaching load should be reduced; finances required for the purpose should be made available, and teachers should be given suitable incentives. There was need for an agency to undertake the responsibility of bringing the developed instruments into market. The existing facilities for post-graduate education in design engineering and instruments technology should be expanded as well as extended in depth.

(Paras 18-20)

9. Expensive equipment should be nationally owned and the institutions in a particular area should be enabled to utilise their services on a mutually agreed basis.

(Para 21)

10. Prototype equipment should be prepared on the basis of the specifications agreed upon by a high-powered committee consisting of the representatives of the institutions, Trade and the Department of Technical Development in relation to the needs of the institutions and the productive capacity available in the country. These

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proto-types should be perfected in the light of experimentation in the engineering colleges and polytechnics.

Particular types of instruments should be concentrated around national institutions for specialising in the branches of knowledge concerned.

(Para 22-23)

11. In order to compile a comprehensive list of highly sophisticated and costly equipment on a nationwide basis indicating its location and study the extent of utilisation of such equipment, a survey committee might be appointed consisting of among others, the representatives of the Ministries of Education, Industrial Development and Company Affairs, the U. G. C., the C.S.I.R. and other concerned organisations.

(Para 25)



AND SCIENTIFIC INSTRUMENTS APPOINTED BY
THE PLANNING COMMISSION

Appointment of the Working Group

The Planning Commission appointed a Working Group on Equipment and Scientific Instruments in January, 1965, under the Chairmanship of Dr. A. Nagaraj Rao, the then Adviser (Industry) in the Planning Commission to draw up detailed estimates of requirement of equipment and instruments for educational institutions at all stages and to review the present position of manufacture, import and procurement as well as supply of equipment to educational institutions, etc. The terms of reference of the Working Group are given in Appendix I. The Working Group was composed of the representatives of the Ministries and the Departments of the Government of India, Planning Commission, University Grants Commission, the manufacturers' organisations, National Council for Educational Research and Training, Council of Scientific and Industrial Research, Medical Council of India, Indian Council of Agricultural Research, Indian Standards Institution, All India Instruments Manufacturers and Dealers' Association and of the Scientific and Surgical Instruments Manufacturers. A complete list of the members of the Working Group is given in Appendix II.

Inaugural Address of Prof. V.K.R.V. Rao

Prof. V.K.R.V. Rao, the then Member (Education), Planning Commission, who inaugurated the first meeting of the Working Group, held on 20th May, 1965, stressed

the urgent need to ensure timely and adequate supply of standard equipment to schools, colleges, polytechnics and research institutions. Prof. Rao said that with an outlay of over Rs. 2,000 crores envisaged in the public sector for educational development in the (old) Fourth Plan, including professional education, vocational and industrial training and scientific research, a stage had been reached in educational programming to adopt a project approach to development and to meet physical and manpower needs for successful implementation of the projects in the Plan. In view of the stringent foreign exchange resources which continued to be an 'inconvenient constraint', it was necessary to maximise indigenous production of equipment and instruments required by educational institutions. Prof. Rao suggested that the Working Group should examine the present position regarding supply of equipment and the capacity of production so as to recommend measures for efficient use of the existing capacity and for creating new capacity with foreign technical collaboration, if necessary, so that the country would be at least near self-sufficient with regard to scientific equipment required by educational institutions by the end of the Fourth Plan. The Working Group was requested to prepare a project report for this purpose so that suitable measures for taking action on the report could be finalised and included in the Fourth Plan.

3. Concluding his remarks Prof. Rao referred to the prospects of export market for our engineering goods in the developing countries in Asia and Africa. With the trends in these countries for expanding educational facilities, Prof. Rao thought it should be possible to export equipment and instruments to those countries after we had developed sufficient capacity of production of these items.

4. It was agreed that while considering the estimates of requirements for equipment, it would be necessary to include the needs of, among others, industrial testing laboratories. ~~It was also pointed~~ out that the instruments required for various educational institutions were to be of varying levels of precision and it would be necessary to identify types, specifications and quality of the items. The Working Group decided that the first step in regard to the tasks assigned to it would be to review the existing shortages of equipment and to project demand for the Fourth Plan in numbers as well as types. The magnitude of requirements as estimated could be matched with the production programmes, existing as well as contemplated. Measures could then be considered to meet the gap between the demand and the availability.

Setting up of Sub-Committees

5. The Working Group decided to set up six sub-Committees to study the requirements of equipment...../4

separately for general science education in schools, science colleges, technical institutions including industrial training institutes, medical colleges, agricultural colleges and research institutions. The composition of these sub-committees is given in Appendix III.

6. Out of the six sub-committees appointed by the Working Group, the committees on Engineering Education and Vocational Training (excluding diploma courses in engineering), Science Education in Schools and Science Education in Universities and Colleges, have completed their work and drawn up the lists of equipment for the respective educational and scientific institutions.

The Committee on Medical Education which has met a number of times, however, could not finalise its report and in the absence of that a tentative list of instruments required for hospitals was drawn up. The lists of equipment for agricultural education have been drawn up but the concerned Committee has not yet not to finalise its report. However, the preliminary list is attached (appendix IV). The Committee on Scientific and Technological Research has also drawn up a list of equipment required for scientific laboratories, but it has not been able to finalise its recommendations. The present report, therefore, dealscontd./

with only three committees mentioned above, which have finalised their reports.

7. It may be mentioned that the Working Group did not get an opportunity to consider the reports submitted by its committees. Further, it has not been possible for the Working Group to address itself to all the tasks assigned to it particularly that of reviewing the manufacture, import and procurement of equipment, etc.

Import of Scientific Equipments

8. As already mentioned, the main task before the Working Group was to draw up detailed estimates of requirements of equipment for various types of educational and research institutions and to indicate the magnitude of demand which should guide the Indian manufacturing industry to expand their productive capacity in relation to the estimated demand. In view of the fact that the precise estimates of enrolment in the Fifth and the subsequent Plans for which these demands would have been relevant, are not yet known, it has not been considered possible to give the total estimates of requirement of each item of equipment needed for various educational institutions. What the committees have been able to do is to draw up lists of equipment for various courses of study and to indicate whether the indigenous capacity is adequate to meet those requirements. Where the Committees thought that the technical know-how in the manufacturing of equipment

in India was not available to a reasonable degree of competence, they have recommended the import of equipment on restricted scale. The idea being that as far as possible, India should meet its requirements of equipment and scientific instruments out of indigenous resources and as mentioned by Prof. Rao in his inaugural address, the continuous constraint of resources makes it imperative for the country to mobilise its own efforts in the production of the equipment and to achieve self-sufficiency in as short time as possible. The Working Group strongly endorses this view and accordingly the lists of equipment have been carefully scrutinised by the committees and wherever there was any possibility of the indigenous production coming up to the required level in regard to the quantum and the quality of instruments, the recommendations have been made to that effect.

9. The Working Group has taken note of the observations made in the meeting held in the Planning Commission on 20th August, 1968, in regard to the question of import of scientific instruments by educational and research institutions. In the meeting, inter alia, it was pointed out that although the instruments industry had made considerable progress in the past two decades their production had continued to remain at a level, which could have been improved for higher precision than at present. This

had resulted in lower generation of demand for the existing units and, therefore, it was considered necessary to assist the indigenous units and prevent the indiscriminate import of scientific instruments by educational and research institutions. It was also pointed out that in a number of cases, applications for the import of scientific instruments were made where specifications slightly varied from those manufactured within the country. On an average, the Directorate General of Technical Development had to deal with 6,000 import applications every year valued at not less than Rs. one crore. Out of this nearly 2,000 to 2,500 applicants could easily use the locally available indigenous material. The demand for imported equipment also resulted on account of predilection of research workers to certain brand, names and lower prices. Quite often complementary instrument had to be imported to suit the individually designed and fabricated instrument. In the meeting it was decided that the criteria for approval of scientific and educational institutions for making them eligible for import of scientific instruments free of customs duty should be reviewed. It was also necessary that an analysis of the imported scientific instruments of the various categories in the past few years may be made by the Ministry of Industrial Development and Company Affairs. Further, the capacities

that exist at present for the supply of various types of scientific instruments and the demand position should also be properly worked out. The Working Group broadly endorses these recommendations.

Import of sophisticated equipment

10. The Working Group has considered the overall question of import of scientific instruments and equipment for educational institutions. It has been felt that specialised equipment and instruments required for research activities were generally of a sophisticated character and were of a very wide coverage. The demand of any particular type being rather limited at any time, about 90 per cent or more of such requirements were being met by imports. The Working Group also recognised that design, development and production of the sophisticated types of precision equipment and instruments required high calibre of scientific and technical personnel with more varied and wider experience. The number of qualified persons with the necessary competence and experience to undertake design and development of such items was also limited at present and therefore a selective approach to these activities would be necessary. It was considered necessary that a few samples of instruments

and equipment which were available in the various laboratories should be studied carefully by the agencies having the required resources and expertise with a view to undertaking their design and development for subsequent production and introducing such modifications as might be considered necessary so as to utilise indigenous materials and production capabilities. It has, however, been felt that there would be need for liberal policy of import of strategic materials and components for this purpose. It was also considered necessary to rationalise and standardise the items based on ~~performance requirements and design development~~ so that steps might be taken to produce these items in the country. The Working Group felt that in view of the limited demands for such items it would be very essential that the Government should provide proper incentives and subsidy both for undertaking design and development and for establishing their production ~~indigenously for the small quantities required~~ from time to time.

11. So far as the spare parts of existing units were concerned, the Working Group felt that the demand should be met by importing parts from the foreign manufacturers. It was not considered desirable at this stage to manufacture them within the country, both from

the point of view of difficulty in regard to spare parts of high precision instruments and on account of economic considerations, as these parts would be required in small numbers. It was, however, felt that the number of these parts should be reduced to the bearest minimum.

Foreign collaboration

12. The Working Group considered the possibility of expanding instrument manufacture in collaboration with foreign manufacturers with a view to catering to a wider market in the developing countries. It was, however, noted that the foreign collaborator generally favoured the idea of making full use of the indigenous capacity already built up. Before this was done, there was a need to improve the quality of indigenous manufacturing units and standardise their specifications so that the foreign collaborator could take full advantage of the local productive capacity.

Requirements of the Ministry of Defence.

13. The Working Group also considered the question of import of instruments required by the establishments under the Ministry of Defence. In this connection, it was pointed out that if sufficient exchange of information and cooperation could be established, the agencies like the Central Scientific Instruments Organisation would be in a position not only to provide for suitable indigenous alternatives for components but also to

improve their performance by suitable modifications. It was felt that the machinery to consider the applications for import licences should have necessary technical expertise acceptable to the user industries and be made responsible to screen the import demands keeping in view the development of the indigenous substitutes.

Import from East European countries.

14. The Working Group noted that there had been considerable import of equipment recently from the East European countries. The view was expressed that these equipments were not always of the requisite standard and were also not tropicalised to suit local weather-conditions. The equipments did not contain instruction manuals which resulted in difficulties of assembly and installation. The Working Group considered it necessary that the State Trading Corporation should look into these difficulties before agreeing to import instruments from the East European countries. The institutions using these instruments should have adequate staff for maintenance and servicing of these instruments.

Quality Control

15. It was brought to the notice of the Working Group that very often the quality of equipment procured on the basis of least quotation was not of requisite standard. In some other cases the quality differed very

much from piece to piece of the same equipment. The Working Group attached the highest importance to the maintenance of the requisite quality of the scientific instruments. One of the suggestions submitted to the Working Group was that a Panel of Experts consisting of representatives of educational institutions using the equipment, Ministries of Education Industry and Supply industrial units using the equipment, the Planning Commission and the Council of Scientific and Industrial Research as well as other concerned organisations should be constituted. The Panel should constantly review the degree of achievements in design and development. This Panel may also screen the lists of equipments and the quality of equipment supplied by various firms, and categorise the firms on the basis of the quality of the products. It was also suggested that with a view to ensuring quality control, various manufacturing units should get the assistance of adequate testing facilities in the national laboratories and other institutions. The Central Scientific Instruments Organisation, the National Physical Laboratory and the Indian Standards Institution could do sample checking of the instruments manufactured by various concerns. They could furnish thereafter the list of such establishments, as according to their judgement, were producing quality goods. Institutions should place

orders with these firms. Any complaint or defect observed during the operation subsequently should be immediately intimated to the Central organisations which had certified these firms. Complaints found to be genuine on examination should be made public as a guidance and warning to the manufacturers as well as a guide to the educational institutions and the public at large.

Repair and Servicing

16. To keep the instruments in good working condition, the need for regular repair and servicing of the instruments and equipments was emphasised. The Working Group felt that there should be either regular servicing agreements with the manufacturers themselves or the laboratory staff of the institution should be trained by the manufacturing units in the servicing of equipment.

17. The working group underlined the need for competent and adequate repair and servicing facilities in the country. It was also emphasised that repair and servicing centres for instruments now being organised by the Central Scientific Instruments Organisation, should be further strengthened and dispersed in different regions of the country so as to cater to the requirements in different region. The Group was informed that Delhi Servicing and Maintenance Unit of the Central Scientific Instruments Organisation had developed capacity to

repair instruments worth lakhs of rupees. The Group recommended the opening of similar Units all over India to undertake repair of instruments and scientific equipments in the country.

Fabrication of Equipment by Educational Institutions.

18. The Working Group considered in detail the question of fabrication of equipment by the educational institutions. It was felt that most of the equipment required in schools and colleges should be fabricated by the institutions themselves. If that was done, the cost of the equipment to educational institution could be reduced substantially. Besides the educational institutions would also have practical experience in manufacturing equipment which could suit their purpose. It was recognised that there were certain difficulties in realising this objective. Some of the difficulties brought to the notice of the Working Group were: heavy teaching load in colleges and universities as well as in schools, the finances required for the purpose and in some cases the time and labour necessary to undergo the long administrative procedures in order to bring a developed instrument in the market. Further, there was lack of realisation of the importance of import substitution as well as inadequate workshop facilities combined with the absence of basic equipment, required for assisting in the improvisation of new instruments.

19. The Working Group, however, felt that by reducing

the teaching load, particularly, on those teachers who gave a promise of having the necessary competence to fabricate instruments and by providing suitable financial assistance for the purpose, it should be possible for the institutions to develop their productive potential. The need for establishing an agency to undertake the responsibility of bringing the developed instrument into market so that teachers' time and labour could be saved, was stressed. It was also considered necessary that the teacher should be given suitable incentives like payment of consultation fee for developing prototypes of equipment, royalty on invention, etc.

20. The equipment, which was used in colleges and polytechnics, was also used by industry. As a matter of fact, industry was the major consumer of instruments and so the manufacture of instruments should not be the entire responsibility of educational institutions. As a corollary to the suggestion made above, the Working Group stressed that post-graduate facilities for design engineering and instrument technology should be created. The existing facilities needed to be expanded as well as extended in depth.

Pooling of equipment

21. The Working Group had before it the cases of a number of highly sophisticated instruments which were

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provided to educational institutions. These instruments were in the custody of the concerned educational institution and other institutions could not possibly utilize their services. In a number of cases it had happened that a specialist in a subject obtained equipment for carrying on some research activity, but by the time the equipment arrived, he was transferred elsewhere. This equipment, therefore, could not be used in the institution which had procured it and so was out of commission for all practical purposes. Some of the instruments were highly expensive and beyond the means of the ordinary institutions to own them. It was also noted that in a number of institutions these highly expensive sophisticated instruments were not fully utilised and thus a situation created in which while an institution had the instruments but could not utilise them to the optimum capacity whereas the other institution, probably in the neighbourhood, did not have the instrument and so were deprived of its utilization. To overcome this difficulty, it was suggested that the highly sophisticated and expensive instruments should be nationally owned and the institutions in a particular area should be enabled to utilise their services on a mutually agreed basis. This would not only lead to the optimum utilisation of the scarce instruments which

were beyond the capacity of all institutions to procure, but also by enabling the students to make use of these instruments, would lead to the general raising of educational standards. Further, it would also obviate the difficulty mentioned above in which the utilisation of the equipment could not take place on account of the transfer of the person concerned who procured it.

Proto-type development

22. The Working Group recommended that prototypes of equipment should be prepared on the basis of the specifications agreed upon by a high-powered committee consisting of the representatives of the institutions, trade and the Department of Technical Development in relation to the needs of the institutions and the capacity of the nation to produce them. These prototypes should be tried out by a number of well-run and well-staffed engineering colleges and polytechnics who should feed back their experience to the organisation preparing them. The prototype should then be perfected in the light of this experience and thereafter passed on for commercial manufacture.

23. It was also suggested that as a large portion of the instrument industry was of a small scale character, it would be advantageous if particular types of instruments

could be concentrated round national institutions specialising in the branches of knowledge concerned. The Electronics instruments manufacturing industry, for example, could centre round the Electronics Laboratory at Pilani. The laboratory could provide testing facilities as well as serve as a sort of an extension centre for providing technical know-how to the industry. ~~Since~~ the instruments industry is a low freight industry, other considerations would not come in the way of the arrangements proposed.

Design and Development

24. The Working Group recommended that much greater emphasis should be laid on design and development. For effective research and development, it was essential that there should be adequate arrangements for feed-back of the experience of users.

Survey of utilisation of equipment

25. The Working Group felt concerned at the lack of proper utilisation of equipment, particularly, sophisticated instruments in educational institutions. It strongly urges the government to appoint a Survey Committee to compile a comprehensive list of highly sophisticated and costly equipment on a nation-wide basis indicating its location and study the utilisation of such equipment. The Committee should be composed of, among others, the representatives

of the Ministry of Education, Industrial Development and Company Affairs, the University Grants Commission, the Council of Scientific and Industrial Research and other concerned organisations. It was also noted that a large number of instruments needed in our laboratories did not require such a high degree of precision as could not be achieved within the country. The degree of precision insisted upon should be carefully related to the practical use to which the instrument was going to be put.





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Reports of the Committees.



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COMMITTEE ON SCIENCE EDUCATION IN SCHOOLS

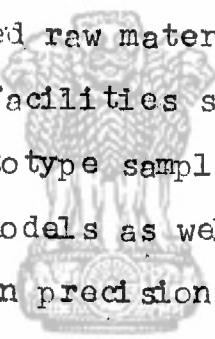
The Committee had one meeting on 6th August 1966 under the Chairmanship of Dr. K.N. Mathur. The other participants, besides officers of the Planning Commission, were Dr. R. N. Roy, Shri M. V. Patankar and Shri Lakshmisagar. The Committee approved the calculations made in a note prepared by the Education Division of the Planning Commission. The Committee agreed to adopt the list prepared by the COPP Team on Science Education in secondary schools in November 1964. A copy of the list is enclosed (Appendix V).

2. The Committee discussed the need for effective quality control in regard to the supply of science apparatus to schools and supported strongly the suggestion of the COPP Team that NCERT should undertake, on a high priority basis, the work of laying down the norms and standards for science apparatus.

3. The Committee also supported the recommendations of the COPP Team for the appointment in the State Directorates of Education of a senior officer with requisite qualifications and experience in the teaching of science to take charge of the programme for promotion of science education in schools. The officer should ensure that grants for

science equipment were sanctioned in time and that the science apparatus purchased by schools was of standard quality. The Committee commended the work done by the recently-established science education units in some of the States.

4. The Committee considered the difficulties of the science apparatus industry in maintaining adequate supplies of science apparatus of good quality and recommended that the Central Government should give facilities to the manufacturers for importing sufficient quantities of the needed raw materials. The Committee also recommended that facilities should be given to the industry to import prototype samples of the latest equipment to serve as models as well as testing equipment needed to maintain precision and quality of science apparatus.



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COMMITTEE ON SCIENCE EDUCATION IN
UNIVERSITIES

The Committee had two meetings: one on 16th June 1966 and the other on the 17th June 1967 under the Chairmanship of Dr. P.S. Gill. The other participants were: Shri V. Krishnamurti, Dr. V.S. Patankar and officers of the Education Division.

2. The Committee scrutinised the list of equipment and instruments for universities and colleges prepared by the University Grants Commission. The Committee particularly examined the categorisation of equipment into locally available items and imported items. The Committee also considered the estimates of additional science enrolment during the next ten years which had been worked out on the assumption that the proportion of science students to the total enrolment in arts, science and commerce subjects at the university stage would increase from about 40% in 1965-66 to about 50% by the end of the Fourth Plan. The proportion of science students was proposed to be established at 50% in the Fifth Plan.

3. The Committee noted that in the universities and colleges using scientific equipment, particularly foreign equipment, it was found that the equipment was not used to the optimum level while at some other places

there were shortages of instruments. The Committee strongly urged that a machinery should be devised to locate the unused equipment in universities, laboratories and other organisations with a view to ensuring the fullest possible utilisation of the available capacity.

4. The Committee was firmly of the view that as a general principle, encouragement should be given to the fabrication of indigenous equipment so that dependence on foreign equipment should be reduced. It was noted that in a number of cases, the instruments required in our laboratories did not need such high degree of precision as could not be achieved within the country. The degree of precision, therefore, needed to be looked into carefully before the imports of such items was allowed.

5. A copy of the list of equipment ~~compiled~~ by the Committee is enclosed (Appendix VI).

ENGINEERING AND TECHNOLOGY
SUB-COMMITTEE ON ENGINEERING EDUCATION AND VOCATIONAL TRAINING

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The Committee met a number of times and the last meeting was held on 16th August 1967 when it was decided that special committees may be constituted to work out the requirements of equipment for various branches of engineering. The names of the special committees appointed for the purpose along with the names of their conveners are given below:

Committee	Convenor
1. Civil Engineering	Prof. V.V.S. Rao, Assistant Professor, I.I.T., New Delhi.
2. Chemical Engineering	Prof. B.N. Das, Department of Chemical Engineering, I.I.T., New Delhi.
3. Electrical Engineering, including Electronics.	Dr. C.S. Jha, Professor of Electrical Engineering, I.I.T., New Delhi (the Convenor expressed his inability to serve on the Committee and, therefore, Dr. P.V. Indiresan was appointed as the Convenor).
4. Aeronautical Engineering.	Prof. S.M. Ramachandra, Indian Institute of Technology, Kanpur.
5. Mechanical Engineering.	Dr. R. C. Malhotra, Associate Professor of Applied Mechanics, I.I.T., New Delhi.
6. Metallurgy*	Prof. E.C. Suba Rao, Head of the Department, Metallurgical Engineering, Indian Institute of Technology, Bombay, was requested to be Convenor of the Committee. He, however, declined to serve on the Committee.

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*In view of the non-acceptance by Dr. Suba Rao to be the Convenor of the Committee on Metallurgical Engineering, the Committee did not meet and therefore no report has been submitted.

2. The Committees were also requested to scrutinize lists of equipment for diploma institutions relevant to their subjects but it was possible for the Committees to take any action in this regard. The following are the main recommendations of the various committees:

Civil Engineering

3. The Committee met on 22nd September 1967 under the Chairmanship of Professor V.V.S. Rao. The following members participated:

Members

1. Dr. K. Seetharamulu
2. Prof. R. Narainah
3. Shri Anand Prakash
4. Prof. T.K. Rao
5. Dr. Jagdish Narayan
6. Prof. V. N. Venkatesh Rao
7. Prof. S. K. Gulati
8. Prof. Amarjit Singh
9. Prof. K.V. Patakar
10. Shri Jagannath Rao
11. Shri S. Subramaniam
12. Dr. B. S. Basavarjiah
13. Prof. V. Chandrasekhar
14. Shri S.V. Patwardhan



The officers of the Planning Commission and Dr. V. M. Ahuja, Dr. R. C. Malhotra of the Indian Institute of Technology, New Delhi, and Shri B. C. Varma of the

Associated Instruments Manufacturers Private Ltd.,
New Delhi, attended by special invitation.

4. The Committee reiterated the view expressed in the Working Group that self-sufficiency in instrumentation should be obtained by the development of indigenous manufacturing capacity. In some cases, however, it was thought necessary that imports should be allowed, particularly in the case of instruments in which the degree of sophistication was so high that it was not produced in India or the number of required equipment might be so small that it might not be economical to produce. Imported equipment was also necessary for preparing proto-types and offering a challenge to the indigenous manufactures. The Committee emphasised a very rigorous quality control because in many cases, the quality differed very much from piece to piece of the same equipment.

5. Regarding servicing, it was recommended that there should be either regular servicing agreements with the manufacturers themselves or the laboratory staff of institutions should be trained in maintenance and servicing of equipment by the manufacturing units.

6. The list of equipment for civil engineering is enclosed. (Appendix VII).

Chemical Engineering

7. The Sub-Committee met on 30th and 31st October 1967 under the Chairmanship of Prof. B. Narayan Das. The following members were present:

1. Dr. B. Ghosh Head of the Department of Chemical Engineering, University of Panjab, Chandigarh.
2. Prof. S. K. Nandi Head of Department of Chemical Engineering, I.I.T., Kharagpur.
3. Shri N. Thandavan Chemical Engineer, A.P.V. Engineering Co., 41 Chowringhee Road, Calcutta-13.
4. Dr. G. Tripathi Principal and Head of Department Chemical Engineering, College of Technology, Banaras Hindu University Varanasi.
5. Dr. D. Venkateswarlu. Head of Department of Chemical Engineering, I.I.T., Madras.
6. Dr. C.R. Mitra Director, H.B.T.I., Kanpur.

8. The Committee finalised the list of equipment for under-graduate courses in chemical engineering. A copy of the list is attached (Appendix VIII).

9. It was pointed out that many instruments and accessories were available from the indigenous sources. But in some cases they were to be designed and fabricated individually at the institutes itself.

Electrical Engineering

10. The sub-committee met on 11th and 12th December, 1967 under Prof. P.V. Indiresan. The following members were present:

1. Prof. M. Chaudhuri, B.I.T.S., Pilani.
2. Prof. K. K. Nair, Osmania University, Hyderabad.
3. Prof. C.S. Jha, I.I.T., Delhi.
4. Prof. I. J. Nagrath, B.I.T.S, Pilani.
5. Prof. R. Subbayan, P.S. College of Technology.
Coimbatore.

11. The sub-committee suggested that a Standing Committee of about 10 members, selected from Electrical Engineering may be appointed to collect and assess all data regarding the equipment indigenously available. Such a committee will be an advisory body, which would act as a source of information for different laboratories.

12. It was suggested that the following laboratories should be provided for running under-graduate courses in Electrical Engineering:

- (i) Service laboratory for the practice of electronics and machines for the sister departments.
- (ii) A machines laboratory.
- (iii) A circuit theory and basic electronics laboratory.
- (iv) An advanced electronics and communication laboratory.
- (v) Controls laboratory.
- (vi) Workshop and project laboratory.
- (vii) Measurement and standard laboratory.

13. It was pointed out that there were quite a few institutions, which are in existence for a number

of years. Many of them had equipments, which were already out of date. As such, it was suggested that provision for replacement of equipment should be made on the following basis:

(a) Electronic equipment after 5 years.

(b) Machines and others after 10 years.

14. Most of the equipment required for undergraduate courses in Electrical Engineering was available from indigenous sources and the sub-committee felt it necessary that organisations like Indian Standard Institution, Chief Inspectorate of Electronics of Defence Ministry, Bangalore, Central Scientific Instruments Organisation, Chandigarh, etc. should test the instruments made by manufacturers and these test reports should be available to educational institutions. The reports should include comments on accuracy, electrical stability, mechanical durability, convenience for maintenance, availability of spare parts; etc. etc.

15. The list of equipment suggested by the sub-Committee is attached (Appendix IX).

Aeronautical Engineering

16. The sub-Committee met under the Chairmanship of Shri S. M. Ramachandra. The following members were present:

(1) Prof. R. Narasimha

(2) Prof. P.N. Murthy

(3) Prof. C.S. Moorthy

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17. The Committee classified the equipment required for conducting under-graduate courses in Aeronautical Engineering into two categories:

- (a) Minimum requirements. These items are marked with*.
- (b) Post-graduate and research. These items are left to the charge of institutions and research workers.

18. The Committee was of the opinion that a broad indication of the fields of interest in the country for the next decade would be desirable since the recommendations for research equipment depend largely on these. The Committee recommended that the Aeronautical Research Committee of the Council of Scientific and Industrial Research be requested to study this question.

19. The sub-Committee pointed out that the 5 Indian Institutes of Technology, the Indian Institute of Science, the National Aeronautical Laboratory and the Hindustan Electricals Ltd. were generally capable of producing indigenously many of the equipments mentioned in the recommended list. Special efforts were required to encourage the indigenous development of some specialised equipment at these and other organisations in India. The Aeronautical Research Committee of the Council of Scientific and Industrial Research may be requested to coordinate these efforts.

20. The list recommended by the sub-Committee is attached (Appendix X).

Mechanical Engineering

21. The sub-Committee met on 16th and 17th October, 1967 under Prof. R.C. Malhotra. The following members were present:

1. Prof. S. Kar
2. Dr. A. Yahaya
3. Dr. S.P. Sukhatme
4. Mr. Y. C. Sud
5. Mr. H. B. Mathur
6. Dr. R.D. Garg
7. Mr. S.N. Saluja
8. Mr. R. T. Russell
9. Mr. B. L. Juneja
10. Mr. N. K. Tiwari.
11. Prof. A. K. Dey
12. Prof. M. L. Mandal
13. Prof. B. K. Gupta
14. Dr. C. K. Grover
15. Mr. S. Dayal
16. Prof. Balbir Singh
17. Dr. B. C. Nakra
18. Prof. L.S. Srinath
19. Prof. B. Karunes
20. Prof. S. P. Luthra.



22. Regarding development of new equipment, it was suggested that teachers in a number of engineering colleges

had developed some equipment in their own colleges, blue-prints of which could be available for general manufacture. It was recommended that a small cell or committee be set up by the Planning Commission to obtain information from all the engineering colleges as to what they had developed and necessary blue-prints may be made for mass manufacture.

23. It was felt that before a teacher could develop equipment and instruments, necessary financial assistance for components etc. may be provided by the Government or the instrument manufacturing industry. In addition, proper incentives must be provided - such as consultation fees for development and national recognition for his efforts.

24. The list recommended by the sub-Committee is attached (Appendix XI).

सत्यमेव जयते



सत्यमेव जयते

PLANNING COMMISSION
(Education Division)

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TERMS OF REFERENCE

The terms of reference of this Working Group may be as follows:

- (i) To draw up detailed estimates of requirements of equipment and instruments for educational institutions at all stages, including agriculture, medical and other professional institutions and research during the next ten years, with particular reference to the Fourth Five Year Plan;
- (ii) To review the present position of manufacture, import and procurement as well as supply of equipment to educational institutions, in terms of number of units, specifications of items required for instructional purposes and procedure followed by institutions in obtaining equipment;
- (iii) To consider the needs for specialised items of equipment, if any;
- (iv) To review the existing arrangements for coordinating the demand for equipment for educational institutions with programme of their manufacture and supply;
- (v) To make recommendations for ensuring timely and adequate supply of equipment to educational institutions;
- (vi) To recommend measures, if any, for increasing indigenous manufacture of these equipment, either in existing units of production or in new units;
- (vii) To recommend proposals, if any, for technical collaboration from abroad for this purpose; and
- (viii) To recommend specific schemes for effective implementation of their recommendations during the Fourth Plan, with such advance-action in the current plan, as may be recommended.

Appendix II

PERSONNEL OF THE GROUP*

(Dr. A. Nagaraja Rao, Adviser, Planning Commission - Chairman)

1. Shri C. Balasubramaniam,
Deputy Secretary,
Ministry of Industrial Development &
Company Affairs,
(Deptt. of Industrial Development) -
(later replaced by Shri K. Raja Ram,
Deputy Secretary) .
 2. Shri V. Krishnamoorthy,
Development Officer (Instruments),
Directorate General of Technical
Development, Ministry of Industry
and Supply (Deptt. of Supply & Tech
Development), New Delhi.
 3. Dr. C.S. Rao,
Technical Advisor,
Andhra Scientific Company Ltd.,
Masulipatnam (A.P.)
 4. ~~Col. S.G. Pendse,~~
Director of Training,
Directorate General of Employment
and Training, Shree Bhakti Bhavan,
Rafi Marg, New Delhi.
 5. Shri S.P. Gupta,
Education Officer,
University Grants Commission,
Bahadur Shah Zafar Marg,
New Delhi.
 6. Dr. R.N. Rai,
Deptt. of Science Education,
National Council of Education
Research & Training,
H-2/X, Model Town,
Delhi.
 7. Dr. K.N. Mathur,
Scientist Emeritus,
Council of Scientific & Industrial
Research, National Physical Laboratory,
Hillside Road, New Delhi.
 8. Dr. S.S. Anand, F.R.C.S.,
Director & Professor of Surgery,
Institute of Post-Graduate Medical
Education & Research,
Chandigarh,
(representing the Medical Council
of India).
 9. The Deputy Agriculture Commissioner
(Education), Indian Council of
Agricultural Research,
Ministry of Food & Agriculture,
New Delhi.
 10. Dr. P.S. Gill,
Director,
Central Scientific Instruments
Organisation, Sector 17, Chandigarh.
 11. Shri G.N. Banerjee,
Mg. Director,
M/s Gensons Private Ltd.,
6, West View Dadar,
P.B. 5576, Bombay 14 (DD)
 12. Shri M.V. Patankar,
Head of Mechanical Engineering Deptt.,
Indian Standards Institution,
Manak Bhavan,
9, Bahadur Shah Zafar Marg,
New Delhi.
 13. Dr. R. Ramanan,
Director, Physics Group,
Atomic Energy Establishment,
Trombay, Apollo Pier Road,
Bombay.
- Alternate
Shri B.D. Toshnival,
Mg. Director,
M/s. Toshnival Bros. Private Ltd.,
198, Janshadji Tata Road,
Bombay-1 (BR)

14. Shri V.R. Reddy,
Asstt. Educational Adviser (Tech.),
Bureau of Higher Education,
(including Technical education),
Ministry of Education, New Delhi.
15. Shri Hari Bhushan,
Director (Engineering),
Industry & Mineral Division,
Planning Commission, New Delhi.
16. Dr. M.A.N. Iyengar,
Asstt. Chief,
Health Division,
Planning Commission,
New Delhi.
17. Shri Ram Surat Singh,
Chief,
Agriculture Division,
Planning Commission,
New Delhi.
18. Shri B.N. Datar,
Chief, Labour & Employment Division,
Planning Commission, New Delhi.
19. Shri A.C. Jaj,
Director (Scientific Research
Resources & Scientific Research
Division, Planning Commission,
New Delhi.
20. Shri D.P. Nayar,
Chief, Education Division,
Planning Commission, - Member Secretary,
New Delhi.



सत्यमेव जयते

Personnel of the Sub-Committees on Equipment
and Scientific Instruments for Educational
Institutions.

I. Science Education in Schools

1. Dr. K.N. Mathur
2. Dr. R.N. Rai
3. Shri M.V. Patankar
4. Shri V. Krishnamoorthy
5. Shri Laxmi Sagar

II. Science Education in Universities

1. Dr. P.S. Gill
2. Shri V. Rama Rao
3. Dr. V.S. Patankar
4. Shri V. Krishnamoorthy
5. Shri G.N. Banerjee

III. Engineering Education and Vocational Trainings:

1. Director, Instruments Research and Development
Establishment, Ministry of Defence.
2. Shri A.K. Mandal
3. Col S.G. Pendse
4. Dr. V.S. Patankar
5. Shri C. Bal subramaniam
6. Shri Hari Bhushan
7. Shri B.N. Datar
8. Shri B.D. Toshniwal
9. Shri V. Krishnamoorthy

IV. Medical Education

1. Col. R.D. Ayyar
2. Dr. S.S. Anand
3. Dr. K.N. Mathur
4. Dr. M.J.H. Writer
5. Shri C. Balasubramaniam
6. Dr. M.A.N. Iyengar
7. Shri G.H. Banerjee
8. Dr. P.S. Gill

V. Agriculture Education

1. Shri S.K. Mukerji
2. Dr. R.N. Rai
3. Shri G.N. Banerjee
4. Shri Ram Surat Singh

VI. Scientific and Technological Research

1. Shri V. Rama Rao
2. Dr. K.N. Mathur
3. Director, Instruments Research and Development Establishment
4. Dr. S.S. Anand
5. Shri M.V. Patankar
6. Shri G.N. Banerjee
7. Shri A.C. Ray
8. Dr. P.S. Gill
9. Shri P.V. Subba Rao
10. Dr. C.S. Rao



List of Scientific Equipments and Instruments
in various Agricultural Colleges.

Name and specifications of the equipment	Minimum re- quirements for 60 under- graduate students	Minimum re- quirements for 10 Post- Graduate students	Category (A-Imported B-Indige- nous)
1.	2.	3.	4.

NOMY

Farm equipment

Soil turning ploughs	5	-	B
Harrows (Disc. & Spring)	2	-	B
Chaff cutter	1	-	B
Cultivators	2	-	B
Seed drills (bullock drawn)	1	-	B
Country ploughs	5	-	B
Thresher Olpad	1	-	B
Beam balance	1	-	B
Spring balance	2	-	B
Pan balance	1	2	B
Bullock cart (Pneumatic tyre type)	1	-	B
Push cart	2	-	B
Dial balance	1	-	B
Spades	60	-	B
Khurpies	60	-	B

1.	2.	3.	4.
16. Kudalies	60	-	B
17. Hoes (a) Singh (Hand)	15	-	B
(b) Hand hoes (with sweep attachment)	20	-	B
(c) Wheel hoes	6	-	B
(d) Akola hoes	5	-	B
18. Paddy Weeder Japanese	1	-	B
19. Paddy thresher Japanese	1	-	B
20. Ridger	1	-	B
21. Tapes	2	-	B
22. Hand rakes	4	-	B
23. Sickles	60	-	B
24. Levelling Karha	1	-	B
25. Dibbler	1	-	B
26. Winnowers	1	-	B
27. Tractor and attachments	-	1	B
<u>Laboratory equipment</u>			
1. Physical balance with weight box	2	-	B
2. Hand lenses	5	2	B
3. Hand Refractometer	1	1	A
4. Nitrogen digestion-om-distillation apparatus	-	1	B
5. Drying ovens	-	2	B
6. Mechanical analysis set (pippette method)	-	1	B

1.	2.	3.	4.
7. Set of sieves for mechanical analysis	-	1	B
8. Mechanical shaker (Electrical)	-	1	B
9. pH Meter (Bechman)	-	1	A
10. Wet sieving apparatus	-	1	B
11. Soil auger	-	1	B
12. Soxhlet apparatus complete with condenser and flask	-	6	B
13. Sand bath	-	3	B
14. Water bath	-	2	B
15. Chemical balance	-	1	B
16. Gooch crucibles	-	6	B
17. Filtration flask with suction pump	-	6	B
18. Cintared glass crucible	-	4	B
19. Muffle furnace, M 5930 with type 291, type B 6	-	1	A
20. Grinding machine	-	1	B
21. Colorimeter, Klett Summerson At. 3790-B and 3788-C, D, D5, 3788-G3, 3788-4 (12 Nos.) 3790-F.	-	1	A
22. Soil testing kits	-	2	B
23. Planimeters	-	2	B
24. Conductivity bridge	-	1	B
25. Soil moisture meter	-	1	B
26. Vacuum pump	-	1	B

1.	2.	3.	4.
27. Hand operated calculators		2	B
<u>BOTANY SECTION</u>			
1. Microscopes			
(a) Students microscope	20 per college	5 per college	B
(b) Dissecting microscope	1	-	B
(c) Demonstration microscope with oil immersion (American optical Co.)	2	-	A
2. Camers Lucida (35 mm Camera) Complex N.Y.	-	5	A
3. Demonstration eye piece	2	10	B
4. Plant press	6	5	B
5. Autoclave	1	-	A
6. Luxonometer	2	5	B
7. Respirosopes	2	2	B
8. Hand lenses	15	10	B
9. Standing set	5	2	B
10. Slide cabinets	1	-	B
11. Slides for demonstrations	1 set	5 sets	B
12. Incubator (C.O.D., Low Temp.)	1	1	B
13. Flame photometer No. 9106 P, Beckman	2	1	A
14. Stage micrometer	-	5	B
15. Ocular micrometer	-	5	B
16. Microtome Rotatory Spencer 815, Arthur Thomas	-	1	A

1.	2.	3.	4.
17. Microscope lamp	-	5	B
18. Hot plate	-	1	B
19. Planimeters	-	2	B
20. Nitrogen estimation assembly	-	2	B
21. PH Meter expanded scale Beckman	-	1	A
22. Ptenekoffers tube apparatus	-	2	B
23. Respirometer	-	2	B
24. Davis apparatus	-	2	B
25. Henike and Hoffmans apparatus	-	2	B
26. Wilmotts bubbler	-	2	B
27. Soxhlet apparatus	-	1	B
28. Suction pump	-	1	B
29. Aspirator	-	1	B
30. Water bath	-	2	B
31. Oven	-	1	B
32. Refrigerator	-	1	B
33. Pan balance	-	3	B
34. Analytical balance	-	1	B
35. Compound Microscopes (Triple Nose-piece, oil immersion)	-	10	A
36. Compound Microscopes (Double Nose-piece)	-	2	A
37. Compound Microscopes (Quadruple Phase constant)	-	1	A
38. Binocular Microscopes lenses x 10	-	10	A
39. Physical balance	-	1	B

1.	2.	3.	4.
40. Chemical balance	-	1	B
41. Torsion balance	-	1	B
42. Vacuum Pump		1	B
43. Centrifuge Electrical	-	1	B
44. Centrifuge hand operated	-	2	B
45. Slide Projector	-	1	B
46. Museum Jars	500 Per College		B
47. Bell Jars	10 Per College		B
48. Dropping bottles of different sizes	2 gross Per College		B
49. Reagent bottles	2 gross Per College		B
50. Measuring Jars of different capacity	4 sets Per College		B
51. Enamel Trays different sizes	4 dozen Per College		B
52. Petridishes different sizes	2 gross Per College		B
53. Test Tubes	4 dozen Per College		B
54. Funnels	2 dozen Per College		B
55. Porcelain Funnels	1 dozen Per College		B
56. Pippetts	2 dozen Per College		B
57. Burettes	2 gross Per College		B
58. Beakers	1 dozen Per College		B
59. Thermometers	1 dozen Per College		B
60. Pestle and Mortar	1 dozen Per College		B

1.	2.	3.	4.
61. Dessicators	1 dozen Per College		B
62. Crucibles	1 dozen Per College		B
63. Burners	2 dozen Per College		B
64. Meter Scales	5 Per College		B
65. Glass rods	5 lb. Per College		B
66. Funnel Stands	2 dozen Per College		B
67. Cork Compressor	1 Per College		B
68. Cork Borers	2 sets Per College		B
69. Test Tube Stands	2 dozen Per College		B
70. Show cases	1 dozen Per College		B
71. Vasculum	1 dozen Per College		B
72. Secator	4 Per College		B
73. Life history charts and models	2 sets Per College		B
74. Racks for Dropping bottles	30 Per College		B
75. Herbarium Steel Almirah	6 Per College		B
76. Garden Tools	2 sets Per College		B
77. Slides and covers	10 gross Per College		B
78. Chemicals			B

PLANT PATHOLOGY SECTION

1. Microscopes:

(a) Students microscopes	20 per college	5 per college	B
(b) Dissecting microscopes	1	-	B
(c) Demonstration microscope with oil immersion (American Optical Co.)	2	-	A

	2.	3.	4.
2. Compound Microscopes (Triple Nose-piece, oil immersion)	-	10	A
3. Compound (Double Nose-piece)	-	2	A
4. Compound Microscopes (Quadruple Phase constant)	-	1	A
5. Binocular Microscopes B.L. Model P.G. 525 Thomes Scientific apparatus and Reagent Cat No. 6546-H.30	-	1	A
6. Incubators	1 per college	-	B
7. Autoclaves	1 per college	-	B
8. Culture Tubes	2 gross per college	-	B
9. Inoculating needles	5 per college	-	B
10. Petri dishes	2 gross per college	-	B
11. Hot Air oven	-	2	B
12. Refrigerators	-	1	B
13. Isolation chamber	1 per college	-	B
14. Camera Lucida, American Opticals	-	5	A
15. Stage and Ocular Micrometers	-	5	A
16. Chemical balance	-	1	B
17. Physical balance	-	1	B
18. Pan balance	-	1	B

1.	2.	3.	4.
19. Microtome Rotatory Spencer 815	-	1	A
20. PH Meter expanded scale Beckman	-	1	A
21. Atomizer	-	5	A
22. Fungicide Dusters	-	2	B
23. Fungicide Sprayers	-	2	B
24. Exhaust Pump	-	1	B
25. Platinum Wire 0.2 mm thick	-	-	B
26. Water Heater (Electric)	-	1	B
27. Electric Germicidal rod	-	1	B
<u>ENTOMOLOGY/ZOOLOGY SECTION</u>			
1. Binocular Dissecting Microscopes	30	10	A
2. Compound Microscopes	3	5	A
3. Binocular for Demonstration Microscope	1	-	A
4. Magnifiers	12	-	B
5. Slide Cabinets	1	1	B
6. Show cases	8	-	B
7. Insect collection boxes	60	10	B
8. Insect collection nets	60	10	B
9. Stretching Boards	60	10	B
10. Camera Lucida	-	2	A
11. Microscope lamp	-	2	A
12. Thermostatic Water Bath	-	1	B
13. Oven	-	1	B

1.	2.	3.	4.
14. Microtome Rotatory Spencer 815	-	1	A
15. Eye-piece Micrometer	-	4	A
16. Stage Micrometer	-	4	A
17. Centrifuge machine International Model HN Centrifuge Capacity 16 to 24 places 15 ml.	-	1	A
18. Autoclave	-	1	A
19. Incubator B.O.D. low temperature	-	1	A
20. Refrigerator	-	1	B
21. Glycerine Bath	-	1	B
22. Electric Stirrer	-	1	B
23. Micro Wet Grinder	-	1	B
24. Analytical Balance	-	1	B
25. Students Cymograph	-	1	B
26. Thermo Hygograph	-	1	A
27. Wet and Dry Bulb Thermometer	-	4	B
28. Max. and Min. Thermometer	-	4	B
29. Rearing Racks	-	2	B
30. Insect Cabinet	-	2	B
31. Insect Breeding cages of various size	-	30	B
32. Relaxing Boxes	-	2	B
33. Setting Boards of different sizes	-	24	B

1.	2.	3.	4.
34. Micromanipulator Eric Sobotka Co., N.Y.	-	1	A
35. Spot. Testing Kit	-	1	B
36. Skeletons (Representatives of all Groups) Glass apparatus	1 per college	-	B
37. Museum Specimens (Representatives of all Groups)			B

38

AGRICULTURAL CHEMISTRY

1. Burners	60	10 per college	A
2. Chemical Balance	20	5	B
3. Physical Balance	5	2	B
4. Gas Plant	1 per college	-	B
5. Distillation Plant	1 per college	-	B
6. Tripod Stand	60	10	B
7. Burette Stand	60	10	B
8. Burettes	60	10	B
9. Pipettes (Different sizes)	60	10	B
10. Nitrogen Distillation apparatus	4	1	B
11. Soxhlet Apparatus	4	1	B
12. Ovens	2	1	B
13. Water Bath	4	1	B

1.	2.	3.	4.
14. Sand Bath	2	1	B
15. Cork Boring machine	1 set	-	B
16. Volumetric flask (250 mm)	60	10	A
17. Gerbers apparatus	2	-	A
18. Furnace (Muffle) Model M-5930 with type 291, type B-6	1 in each college	-	A
19. Water Bottles	30	10	B
20. Kjeldahlls apparatus (set of 6)	1 per college	-	B
21. Dessicator	30	10	B
22. Crucible	60	10	B
23. Crucible Tongs	60	10	B
24. Pipe clay triangle	60	10	B
25. Test Tube stands	30 per college	-	B
26. Funnel Stands	60 per college	-	B
27. Constant temprature - electrical drying (ovens)	-	1	A
28. pH Meter Beckman	-	1	A
29. Grinding Mill	1 per college	-	B
30. Autoclave	-	1	A
31. Incubator (low temperature 50 to 50 C) AC 220-V precision Science Co.	-	1	A
32. Centrifuge electrical	-	1	B

1.	2.	3.	4.
33. Colorimeter photo electric	-	1	A
34. Microscope (Research type)	-	1	A
35. Electric Hot Plate	-	1	B
36. Set of sieves for mechanical analysis	-	1	B
37. Chamberlain filter-candle	-	1	B
38. Shaker for mechanical analysis (Electrical)	-	1	B
39. Platinum crucible dishes and wires		1 each	B
40. Agate apparatus	-	1	B
41. Iron and porcelain mortar	-	1	B
42. Soil Auger	-	1	B
43. Refrigerator	-	1	B
44. Stop watch	-	1	B
45. Vacuum pump	-	1	B
46. Conductivity apparatus	-	1	B
47. Colony counter	-	1	B
48. Spectrophotometer Beckman	-	1	A
49. Soil Testing kit	-	1	B
50. Chemicals	-	1	B
51. Glasswares, slides, cover slips, Reagent bottles, test tubes, beakers etc.	-	-	B

1.	2.	3.	4
<u>HORTICULTURE</u>			
1. Budding knives	20	10	B
2. Secateurs	6	-	B
3. Spades	20	-	B
4. Khurpies	20	-	B
5. Pruning knives	12	-	B
6. hand hoes	6	-	B
7. Hedge Shears	6	-	B
8. Wheel hoes	4	-	B
9. Lawn Mower	1 per college	-	B
10. Hand Trowels	12	-	B
11. Hand Forks	6	-	B
12. Fruit preservation, bottling and canning equipment	1 set in each college	-	B
13. Tree loppers	2	-	B
14. Microscope (Research)	-	5	A
15. Varring blender	-	1	A
16. Incubators	-	1	A
17. Oven	-	1	B
18. Water Bath	-	1	B
19. Microtome Rotatory - Spencer 815	-	1	A
20. Refrigerator	-	1	B
21. Refractometer (Hand) O-58	-	3	A

1.	2.	3.	4.
22. Centrifuge	-	1	A
23. Chemical balance	-	1	B
24. Hand Tally Counters	-	5	B
25. Mettler balance, direct reading	-	1	A
26. Hemacytometer set, Spencer Model	-	1	A
27. Chromatographic cabinet	-	1	A
28. Colorimeter with accessories	-	2	A
29. pH Meter I&N Model glass electric expanding scale	-	1	A
30. Hydrometer	-	1	B
31. Dissecting microscopes Bausol & Lomb Stereozoom	-	2	A
32. Can sealer, Dixie - make double seamer	-	1	A
33. Ribbon filament microscopio illuminator	-	3	A
34. Electric calculator - Facit make	-	1	A
35. Water pilfier Banstead model EBD-1	-	1	A
36. Watter pilfier Banstead model	-	1	A
37. Muffle furnace tempo type-220-V.	-	1	A
38. Steam Jacketted keettle 5 gallon capacity	-	1	B

1.	2.	3.	4.
39. Power sprayers and Power dusters	-	2	B
40. Canning retort	-	1	B
41. Fruit juice extractor	-	1	B
42. Jelmeter	-	1	B
43. Fruit juice pasteurizer	-	1	B
<u>AGRICULTURAL ECONOMICS</u>			
1. Calculating machine Model SNE- Special Item No. 50-417-2	1 per college	-	A
2. Physical balance	2 per college	-	B
3. Magnifying glasses	-	10	B
4. Enamelled plates	-	20	B
5. Measuring tapes (100' & 500')	-	5	B
6. Proforma and records	-	200	B
<u>AGRICULTURAL EXTENSION</u>			
1. Magic lantern	1 per college	-	B
2. Loud speaker	1 -do-	-	B
3. Mike	1 -do-	-	B
4. Gramophone	1 -do-	-	B
5. Generator	1 -do-	-	B
6. Projector (Slide-cum- strip)	1 -do-	-	B
7. Film Projector, complete set	1 -do-	-	B

1	2	3	4
8. Tape recorder, portable tape model SRT-401 delux	1 per college	-	A
9. Public Address equipment	1 per college	-	B
10. Movie camera with projector 8 mm	-	1	A
11. Ordinary box cameras	-	10	B
12. Folding cameras	-	1	B
13. Demonstration set of agricultural implements	-	-	B
14. Demonstration set of Plant projection equipment	-	-	B
15. Demonstration set of fruit preservation	-	-	B
16. Demonstration set of Poultry	-	-	B
17. Equipment for setting up of information centre	-	-	B
18. Other audio-visual aids (flash cards, flannelograph, models, charts etc.)	-	-	B
19. Calculating machine (hand operated)	1 per college	-	A
20. Art table	1 per college	-	B
21. Typewriter	1 per college	-	B
22. Cyclostyling machine (hand operated)	1 per college	-	B
23. Transport. (Jeep)	1 per college	-	B

1.	2.	3.	4.
<u>AGRICULTURAL ENGINEERING</u>			
1. Plane table with accessories	2	-	B
2. Dumpy's level	2	-	B
3. I.O.P. Level	2	-	B
4. Prismatic compass	2	-	B
5. Surveying chains with accessories	10	-	B
6. Seed Drill	1	-	B
7. Cultivator with seeding attachment	1	-	B
8. Dibbler	1	-	B
9. Tractor (wheel type with ploughs, harrows and cultivators and trailers)	1	-	B
10. Portable oil engine and pump sets 5 H.P.	1	-	B
11. Petrol engine 6 H.P.	1	-	B
12. Electric Motor and pump sets 7½ H.P.	1	-	B
13. Centrifugal pump	1	-	B
14. Flour mill or concrete grinder 6 B.H.P.	1	-	B
15. Olpad thresher	1	-	B
16. Power thresher Kubota Co. Japan	1	-	A
17. Paddy thresher	1	-	B

1.	2.	3.	4.
18. Winnowing fan (Hoshaugabad) - cossul	1	-	B
19. Winnowing fan (3 blades) cossul	1	-	B
20. Bullock drawn mower (4 ft.)	1	-	B
21. V Notch Measuring tank	1	-	B
22. Hand chaff cutter	1	-	B
23. Power Chaff cutter	1	-	B
24. Bullock Drawn cane crusher	1	-	B
25. Water lifts:			
(a) Persian wheel	1	-	B
(b) Screw pump	1	-	B
(c) Chain pump	1	-	B
(d) Double chain pump	1	-	B
26. Smithy tools	-	-	B
27. Carpentry tools	-	-	B
28. Dynamometer (self) recorder)	1	-	A
29. Planograph stencil set No.9	1	-	B
30. Line Ranger	1	-	B
31. Steel Almirah	1	-	B
<u>DAIRY AND ANIMAL HUSBANDRY</u>			
1. Area of the farm		25 acres	B
2. Bullock pairs	2	-	B
3. Milk cows	15	-	B
4. Buffaloes	5	-	B

1.	2.	3.	4.
5. Milking pails	5	-	B
6. Milking cans	3	-	B
7. Milk measures	1 set	-	B
8. Cream separators, electrically operated	2	-	B
9. Butter churns	3	-	B
10. Butter workers	3	-	B
11. Butter prints	1 set	-	B
12. Refrigerator	1	-	B
13. Centrifuge machine, Klett Summerson test tube model	1	-	A
14. Milk butyrometer	5 dozen	-	B
15. Burets	10	-	B
16. Pipetts	36	-	B
17. Physical balance	3	-	B
18. Analytical balance	1	-	B
19. Steel utensils (ghee, curd, khoa)	-	-	B
20. Ice-cream freezer	4	-	B
21. Lactometers	6	-	B
22. Richmonds scale	6	-	B
23. Hand sealing machine for bottles/cans	1	-	B
24. Herd recorder	1	-	B
25. A.I. sets	1	-	B
26. Branding sets	2	-	B

1.	2.	3.	4.
27. Identification marking: sets	2	-	B
28. Castrator	2	-	B
29. Models of different Breeds	-	-	B
30. Models for internal anatomy	-	-	B
31. Reproduction physiology models	-	-	B
32. Important Veterinary instruments	-	-	B
33. Birds and poultry instru- ments	-	-	B
<u>ANIMAL BREEDING</u>	<u>For 10 colleges:</u>		
1. Refrigerators, 2 cu.ft.	-	2	B
2. Research binocular microscope Bausch & Lomb model	-	2	A
3. Students microscope	-	5	A
4. Sterilizer	-	1	B
5. haemocytometers complete	-	1	A
6. Hot air oven	-	1	B
7. A.T. complete sets	-	5	B
8. Egg testing machine	-	1	B
9. Egg incubator	-	1	B
10. Physical balance	-	-	B
11. Hand lenses	-	10	B
12. Dissecting microscope	-	6	B
13. microtome, Rotatory type	-	1	A

1.	2.	3.	4.
<u>ANIMAL NUTRITION</u>			
1. Nitrogen digestion and distillation sets	-	2	B
2. Ether extraction set	-	1	B
3. Grinding machine	-	1	B
4. Muffle furnace	-	1	A
5. Digestion co-efficient cages complete with bags	-	1	A
6. Respiratory chamber for R.Q. ratio	-	1	A
7. Bomb calorimeter	-	1	A
8. Cattle weighing bridges	-	1	B
<u>DAIRY TECHNOLOGY</u>			
1. Butter churner	-	2	B
2. Butter workers	-	2	B
3. Cream separators (electrically operated)	-	4	B
4. Centrifuge machine (hand operated)	-	2	B
5. Complete cheese making set	-	1	B
6. Ice-cream freezer	-	2	B
7. Refrigerator 9 cu.ft.	-	1	B
8. Boiler	-	1	B
9. Cheese boiler (steam Jacketed stainless steel)	-	1	B
10. Model of H.T.S.T. and batch pasteurizer	-	1	A
11. Stainless steel utensils	-	-	B

1.	2.	3.	4.
<u>DAIRY CHEMISTRY</u>			
1. Chemical balance	-	5	B
2. Hot air ovens	-	2	B
3. Water bath	-	1	B
4. PH Meter expanded scale, Backman	-	1	A
5. Colorimeter	-	1	A
6. Tintometer Lovibond Model No. 2 complete with accessories	-	1	A
7. Butyrorefractometer	-	5	B
<u>DAIRY MICROBIOLOGY</u>			
1. Big horizontal autoclave electrically operated	-	1	A
2. Vertical autoclave electti- cally operated	-	1	A
3. Hot air oven	-	3	B
4. Incubators	-	3	A
5. Phase contrast microscope	-	1	A
6. Refrigerator	-	2	B
7. Colonycounter	-	1	A
8. Nephelofluxometer	-	1	A
9. Tintometer comparator with resazurin and other PH dies discs	-	1	A
10. Arnold Sterilizer	-	1	A
11. Electrically operated water bath	-	1	B
12. Dental Drill	-	1	B
13. U.V. Lamp	-	1	B
14. Inoculation chamber	-	1	B

LIST OF SCIENCE EQUIPMENT AND APPARATUS FOR HIGH SCHOOLS

A- PHYSICS

Sl. No.	Name of the Article	Quantity	
		Essential	Desirable
(1)	(2)	(3)	(4)
	<u>Mechanics</u>		
	<u>Demonstration (Apparatus)</u>		
1.	Wooden Vernier Calliper (model)	1	
2.	Wheel and axle	1	
3.	Pulleys (different type)	1 (set)	
4.	Inertia apparatus (ball and spring type)	1	
5.	Barker's Mill	1	
6.	Centre of gravity toys	1 (set)	
7.	Guinea and feather apparatus		1
8.	Levers of different kinds	1 (set)	
9.	Laws of parallelogram of forces apparatus (complete)	1	
10.	Inclined Plane (complete)	1	
11*	Apparatus to show that liquids seek their own level	1	
12.	Hydrometer for light & heavy liquids	1 (set)	
13.	Nicholson's Hydrometer with jar	1	
14.	Hydrometer for battery testing	1	
15.	Lactometer	1	
16*	Pascal's law apparatus	1	
17.	Hydraulic Press (working model)	1	
18.	Submarine (model)		1
19.	Flushing siphon		1
20.	Aneroid barometer	1	
21.	Tube and cup for simple barometer	1 (set)	
22.	Fortin's barometer		1
23.	Syringe	1	

* May be improvised.

(1)	(2)	(3)	(4)
24*	Cartesian diver		
25*	Rain Gauge	1	
26.	Vacuum pump (piston type) with one bell jar 25 cm. diameter	1	
27.	Suction and force pumps (working model-transparent)	1 (set)	
28.	Aeroplane (working model)		1
29.	Rocket model		1
	<u>Heat</u>		
30.	Alcohol thermometer (large size)	1	
31.	Clinical thermometer	1	
32.	Fix's maximum and minimum thermometer	1	
33.	Differential air thermoscope	1	
34.	Linear expansion apparatus (pointer type)	1	
35.	Ball and ring; Bar and gauge	1 (each)	
36.	Compound bar of brass and iron (with handle)	1	
37.	Boyle's law apparatus complete	1	
38*	Dry and wet bulb hydrometer	1	
39*	Ingen Hausz's apparatus or Adair's apparatus for showing conductivity	1	
40.	Rods of different metals, 60 cm. length and 0.5 cm. diameter	1 (set)	
41.	Leslie's cubes	1 (set)	
42.	Davy's safety lamp	1	
43*	Convection apparatus	1	
44.	Thermos flask	1	
45*	Thermo-couple	1	
46.	Crooke's radio-meter	1	

* May be improvised.

(1)	(2)	(3)	(4)
47.	Steam Engine (working model)	1	
48.	Fire alarm (working model)	1	
49.	Refrigeration (model)		1
50.	Air conditioning (model)		1
	Light		
51.	Convex Mirror (15 cm. aperture)	2	
52.	Parabolic mirror	1	
53.	Optical bench with accessories (Metallic)	1	
54.	Lenses of different types (set of six)	1	
55.	Telescope astronomical (magnifying power x 15)	1	
56.	Microscope compound (magnifying power x 50 x 100)	1	
57.	Binocular (magnifying power x 20)		1
58*	Periscope (model)	1	
59*	Kaleidoscope	1	
60.	Hollow glass slab	1	
61.	Two mounted thin plane mirrors (15 & 10 cm)	1	
62.	Mounted thick mirror (hinged) for multiple images	1	
63.	Hollow glass prism	1	
64*	Newton's colour disc with rotating wheel	1	
65.	Colour slides for showing the mixing of colours		(1 set)
66.	Human eye (working model)	1	
67*	Pin hole camera	1	
68.	Box camera	1	
69.	Simple model for showing the persistence of vision	1	

*May be improvised.

(1)	(2)	(3)	(4)
70.	Optical disc to demonstrate laws of reflection and refraction (Hartle's Disc)	1 (set)	
71.	Hollow cube with air cell attached for showing total internal reflection of light	1 (set)	
72.	View master		
	Sound		
73.	Demonstration apparatus for wave motion	1	
74.	Parabolic reflector (metallic) with adjustable stand	1	
75.	Tuning forks-complete set of eight	1 (set)	
76*	Resonance tube apparatus	1	
77.	Toothed wheel apparatus	1	
79.	Siren with indicator		1
79.	Scnometer	1	
80.	Adjustable organ pipe (open and close)	1 (set)	
81.	Galton whistle		1
82.	Ripple tank (P.S.S.C. type)	1	
83.	Gramophone		1
84.	Amplifying unit		1
85.	Belljar (15 cm. diameter) with electrical bell	1	
<u>Magnetism & Electricity</u>			
86.	Magnetic compass	1	
87.	Mariner's compass		1
88.	Magnetic Dip needle	1	
89.	Magnetic globe (medium size working model)		

* May be improvised.

(1)	(2)	(3)	(4)
90.	Different types of magnets (including natural and oxide magnets)	1 (set)	
91.	Metallic conductors of different shapes (mounted)	1 (set)	
92.	Leyden jar with removable coatings	1	
93*	Pith ball pendulum	2	
94.	Faraday's butterfly net	1	
95.	Van de Graff generator (working model)		1
96*	Apparatus to demonstrate the magnetic effect of current	1	
97.	Galvanoscope	1	
98.	Electromagnet (ordinary U shaped)		1
99*	Cells:		
	(a) Voltaic	1	
	(b) Daniel	1	
	(c) Bunsen	1	
	(other cells included in laboratory apparatus)		
100.	Resistance box, open view	1	
101.	Different types of keys	1 (set)	
102.	Rheostat	1	
103.	Demonstration board for series and parallel circuits	1	
104.	Moving magnet and coil galvanometer, open view (working model)	1 (each)	
105.	Joule's calorimeter		1
106.	Nichrome wire coiled round a mica sheet (heating element)	1	
107.	Dynamo AC/DC (working model)	1	
108.	Electric motor -AC/DC (working model)	1	
109.	Simple transformer	1	

* May be improvised.

(1)	(2)	(3)	(4)
110.	Spinthariscopes	1	
111.	Demonstration apparatus for induced currents	1	
112.	Barlow's wheel	1	
113*	Voltmeter	2	
114.	D.C. Voltmeter 0 - 1.5 volts	1	
115.	D.C. Ammeter 0 - 1 amp.	1	
116.	Model of a telephone set	1	
117*	Model of a telegraph set	1	
118.	Crystal detector with headphones		1
Experiments			
<u>Mechanics</u>			
119.	Metallic spherical bob with a hook	12	
120.	Metallic cylinder (small size - assorted metals for use with callipers)	12	
121.	Spring and pans for Hooke's law verification	12	
122.	Wooden bridges for R.D. experiment	6	
123.	R.D. bottles	12	
124.	Hare's apparatus on stands	9	
125.	U-tubes on stands	6	
126.	Over-flow vessels (unbreakable plastic or metallic)	12	
<u>Heat and Light</u>			
127.	Calorimeter with stirrer and jacket	6	
128.	Steam generators	6	
129.	Hypsometer (with copper tubes)	6	
130.	Plane mirror strips with a support to the verticle	24	
131.	Concave mirror 5 cm and larger aperture (of different focal lengths)	12	

* May be improvised.

(1)	(2)	(3)	(4)
132.	Glass slabs (preferably 8 cm x 12 cm)	6	
133.	Lenses, double convex, 5 cm. aperture (of different focal lengths) Double convex, 2.5 cm aperture (5 to 7 cm. focal length)	12 4	
134.	Suitable holders and uprights for lenses and mirrors (wooden with V slots)	24	
135.	Glass prism 90° isosceles	2	
136.	Glass prism - 60°	6	
137.	Candle stand with wire gauze fittings	12	
138.	Ground glass screen	6	
<u>Magnetism and Electricity</u>			
139.	Magnets in pairs, different sizes (oxide magnets)	12 pairs	
140.	Magnetic needle on pivot	12	
141.	Magnetic needles (for lines of force)	12	
142.	Steel knitting needles	24	
143.	Aluminium leaf electroscope, simple	6	
144.	Electro-phorus	6	
145.	Glass rods	12	
146.	Ebonite rods	12	
147.	Catskin pieces	12	
148.	Flannel or nylon pieces	12	
149.	Proof plane	6	
150.	Cells:		
	(a) Leclanche	12	
	(b) Dry cells with terminal screws	6	
151.	Single-way key (plug type)	6	
152.	Lead accumulator, 2 volts	4	
153.	Ammeter D.C., 0-1.5 amp.	4	

(1)	(2)	(3)	(4)
154.	Voltmeter, D.C., 0-3 volts Voltmeter, D.C., 0-10 volts	4	1
155.	Voltmeter for mains (AC./DC) 0-300 volts		1
156.	Rheostat - 1 amp, 36 ohms.	4	
157.	Electric bell	6	
158.	Torch bulb (1.5 volts) with holders	12	
159.	Miniature switches	12	
160.	Cut-outs	12	
<u>Equipment Common to All Units in Physics</u>			
161.	Physical balance with weight box	6	
162.	Spring balance; 100 gm 250 gm 500 gm	6 6 6	
163.	Triple beam balance		1
164.	Metre scales; Half Full	12 12	
165.	Vernier callipers	6	
166.	Screw gauge	6	3
167.	Stop clock	1	3
168.	Stop watch	1	
169.	Spirit Level	2	
170.	Drawing boards (medium size)	12	
171.	Set squares (for black board)	1 (set)	
172.	Pairs of Compass (Geometrical)	12	
173.	D.C.C. copper wire 22-24-26 S.W.G.	500 gm.	
174.	Nichrome wire 28-30-32 S.W.G.	250 gm.	
175.	Flexible wire (Plastic covered)	25 meters	
176.	Plumb line	6	
177.	Battery charger with a metal rectifier		1

B. CHEMISTRY

S. No.	Name of the Article	Quantity	
		Essential	Desirable
(1)	(2)	(3)	(4)

Demonstration (Apparatus)

1.	Chemical Balance (in case) & weight box	1	
2.	Radiometer tubes	1	
3.	Bell Jar (20 cm diameter)	1	
4.	Funnel separating	1	
5.	Calcium chloride tubes	4	
6.	Thermometers (marked $\frac{1}{10}^{\circ}$ C)	2	
7.	Mercury trough	1	
8.	Filter pump (metallic)	1	
9.	Crystal models (glass/wooden/plastic)	1 (set)	
10.	Copper still for distillation of water	1	
11.	Platinum wire (5 cm. fused in glass)	3	
12.	Water still (for distillation of water)	1	
13.	Glass cutter for rods	2	
14.	Photographic developing kit	1	
15.	Leibig's condenser	2	
16*	Fire extinguisher (Demonstration model).	1	
17*	Atomic model	1 (set)	
18.	Mineral collection	1 (set)	
19.	Alloys	1 (set)	

Apparatus for Experiments

20.	Beaker with lip	
	(a) 100 cc.	48
	(b) 250 cc.	48
	(c) 500 cc.	

(1)	(2)	(3)	(4)
21.	Flask flat bottom		
	(a) 100 cc.	12	
	(b) 250 cc.	48	
	(c) 500 cc.	6	
22.	Distilling flask round bottom 300 cc.		2
23.	Crystallising dish 10 cm diameter		2
24.	Woulfe's bottle 250 cc.	24	2
25.	Bottles narrow mouth mushroom stopper 500 cc. (Polythene)	24	
26.	Bottle reagent with names (Polythene)	48	
27.	Measuring jars		
	(a) 10 cc.		2
	(b) 50 cc.	6	
	(c) 100 cc.	12	
	(d) 500 cc.		2
	(e) 1000 cc.		2
28.	Bottles reagent 8 oz., 16 oz. with wide mouth	48	
29.	Bottles reagent 2 oz.	48	
30.	Funnels (7.5 cm diameter)	24	2
31.	Funnel for burettes (Polythene)	4	2
32.	Retort 500 cc.	12	3
	Retort 250 cc. with long necks	12	
33.	Pneumatic trough (rectangular tin with beehive arrangement)	24	2
34.	Mortar and pestle		
	(a) 10 cm dia.	3	1
	(b) 25 cm. dia.		1
35.	Calcium chloride tubes		
	(a) U - type 15 cm. approx.		2
	(b) U - type with side tubes		2

(1)	(2)	(3)	(4)
36.	Glass filter pump		1
37.	Test tubes 12.5 cm. x 1.6 cm.	2 gross	
38.	Test tubes, hard-glass 1.5 cm x 1.9 cm	24	
39.	Glass tubing assorted	13 kg.	
40.	Glass rod assorted	3 kg.	
41.	Burette with stop cock 50 x 1/10 cc.	12	2
42.	Pipette		
	(a) 10 cc,	12	
	(b) 20 cc.	12	
	(c) 25 cc.		1
	(d) 50 cc.		1
43.	Thermometer 350° (Reading 1° C)		1
44.	Fitter paper circular, pieces 12.5 cm.	600	
	-do- 15.0 cm.	300	
	-do- Plain	2 quire	
45.	Rubber tubing assorted	30 meters	
46.	I.R. connection tubing	15 meters	
47.	Cork-borers, set of three	12 sets	
	Cork-borers, set of six		1
48.	Cork-ordinary assorted (Valvet)	6 gross	
49.	Cork presser	2	
50.	Berenger Balance with weights	2	
51.	Clay pipe triangle	24	
52.	Deflagrating spoons with tin caps	24	
53.	Foot bellows		1
54.	Pinch Cook assorted	12	
55.	Retort stands (with heavy base)		
	(a) large		2
	(b) Small	22	

(1)	(2)	(3)	(4)
56. Additional rings for retort stand		12	
57. Wooden clamp			1
58. Funnel stand; double		12	3
59. Burette clamps		12	
60. Thistle funnels 2.5 cm. diameter (Preferably Polythene)		24	
61. Asbestos sheet 25 cm x 25 cm.		24	
-do- (large size)		1	
62. Diffusion apparatus (porous-pot, tube etc.)			1
63. Glass trough, large, 45 cm dia.			2
64. Copper flask (2 litres)			1
65. Watch glasses		24	
66. Bunsen Burners (if gas supply is available) otherwise Spirit Lamps		24	
67. Flame spreader for bunsen burner		12	
68. Spatulas (metal)			1
Spatulas (horn double)		12	
69. Book of labels		24	
70. Litmus books (red & blue)		2 gross	
71. Tripod stands		24	
72. Crucible tongs		24	
73. Porcelain dishes 10 cm. dia.		24	
74. Graduate flasks			
(a) 100 cc.			2
(b) 200 cc.			2
(c) 250 cc.			2
(d) 1000 cc.			2

* May be improvised.

(1)	(2)	(3)	(4)
75.	Water baths with rings	2	2
76.	Crucible with lids and clay pipe triangle	8	
77.	Small J-tube, height 10 cm diameter 1.3 cm.	6	
78.	Wire gauze spoons for sodium	6	2
79.	Triangular files and round files	24 each	
80.	Gas collecting jar (15 cm) with round glass cover (Small size)	60	
81.	Spare covers for gas jars	48	
82.	Brushes for test tubes	4 dozen	
83.	Test tube holder	24	
84*	Test tube-stand	24	
85.	Cobalt glass	12	
86.	Petridishes 8.5 cm. dia.	24	
87*	Sand bath	12	
88.	Thermometer, - 10 °C to 110 °C	24	
89.	Drying cones	12	1
90.	Wire gauze (asbestos covered)	24	1

* May be improvised

C. BIOLOGY

S. No.	Name of the Article	Quantity	
		Essential	Desirable
(1)	(2)	(3)	(4)

I - Apparatus

1.	Microscope with ocular objectives 10 x 40 x and two eyepieces	1
2.	Dissecting microscope with rack and pinion (magnifying power x 10)	6
3.	Reading glass 3" diameter	2
4.	Magnifiers single folding	2
5.	Eye-piece x 10 with pointer	1
6.	Klinostat	
7*	Simple auxonometer (with lever arrangement)	1
8*	Simple respiroscope	1
9*	Simple potometer	1
10.	Light screen	2
11.	Beranger's balance (with wt. box)	1
12.	Thermometers, - 10°C to 110°C	2

II - Laboratory Equipment

13.	Dissecting trays and dissecting boards	20
14.	Dissection instruments	1 set
15.	Bone cutter	2
16.	Big Scissors	2
17.	Hammer (small)	3
18.	Mounted Needles	72
19.	Brushes camel hair	12

* May be improvised.

(1)	(2)	(3)	(4)
20. Razor		1	
21. Insect drying box		2	
22. Herbarium mounting sheets		100	
23. Herbarium Press 20" x 12"		1 pair	
24. Drying papers		100	
25. Sharpening cone		1	
26. Strop		1	
27. Dessicator		1	
28. Cork borer		1 (set)	
29. Retort stand (with clamps and box heads)		3	
30. Funnel stands (Wooden)		3	
31. Insects-collecting nets		2	
32. Test-tubes stand		2	
33. Pins (various sizes)		2 packets	
34. Entomology pins (or insect pins)		1 gross	
35. Spirit lamp		1	
36. Rubber tubing (assorted)		5 yds	
37. Scalpels		2	
38. Cork bark (assorted)		6 do	
39. Forceps - 12.5 cm and 40 cm.		2	
40. Pinch cock (screw type)		3	
41. Vasculum		1	
42. Flower pot 8 (assorted, earthenware 8" x 10")		24	
43. Watering can (with rose)		1	
44. Mugs (enamel)		2	
45. Buckets		2	
46. Refuse box with lid		1	

* May be improvised.

(1)	(2)	(3)	(4)
III - <u>Glass Ware and Museum Ware</u>			
47.	Belljar 20" x 12" (50 x 30 cm)	1	
48.	Glass plate 14" x 14" (35 cm x 35 cm)	1	
49.	Aspirator, 5 litres	1	
50.	Funnel, 4" diameter (10 cm)	2	
	Funnel, 3" diameter (7.5 cm.)	2	
51.	Beakers, 1/2 litre	3	
	Beakers, 1/4 litre	3	
52.	Battery Jars, Cylindrical (1 litre capacity)	1	
53.	Museum Jar, 8" x 2" assorted (20 x 5 x 20 cm) (with rectangular lid)	48	
	Do. Cylindrical with bakelite screw caps	24	
54.	Thistle funnel	3	
55.	Gas Jars (with lids)	2	
56.	Microscope slides, 3" x 1" (7.5 x 2.5 cm)	1 Gross	
57.	Cover Glasses 7/8" x 7/8" (2.2 x 2.2 cm)	12	
58.	Watch glass, 3" diameter	12	
59.	Hard glass test tubes	12	
60.	Test tubes (ordinary)	72	
61.	Reagent bottles with stoppers, narrow mouth 250 cc. capacity	6	
62.	Drop bottles	12	
63.	Stain bottles	12	
64.	Winchester bottle (2½ litre capacity)	3	
65.	Glass tubings (assorted)	2 lbs.	
66.	Finger bowls	6	
67.	Circular glass troughs	2	
68.	Enamel tray 12" x 9" (30 x 23 cm)	1	
69.	Enamel tray 9" x 6" (23 x 15 x cm)	1	

(1)	(2)	(3)	(4)
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Botany IV Charts

70.	Cell division, mitosis	1
71.	Structure of dicot stem	1
72.	Structure of monocot stem	1
73.	Structure of leaf	1
74.	Structure of dicot root and monocot root	1
75.	Structure of root tip	1
76.	Parts of a typical plant	1
77.	Typical flower and its parts	1
78.	Fruits - different kinds of fleshy and dry fruits	1
79.	Seed - dispersal of seed	1
80.	Germination epigeal and hypogeal	1
81.	Monocot seed and parts	1
82.	Dicot seed and parts	1
83.	Algae Chlamydomonas Spirogyra	1
84.	Mushroom	1
85.	Bacteria	1
86.	Moss-life history	1
87.	Fern-typical fern and its parts	1
88.	Vegetative propagation - grafting etc.	1
89.	Food chain	1
90.	Different kinds of leaves and their modifications	1
91.	Nitrogen cycle in nature	1
92.	Amoeba - structure and reproduction	1

(1)	(2)	(3)	(4)
<u>Zoology</u>			
93.	Life cycle of malarial parasite	1	
94.	Liverfluke	1	
95.	Tape worm	1	
96.	Cell-typical	1	
97.	House fly-life history	1	
98.	Mosquito - life history-culex and anophales	1	
99.	Butterfly - life history	1	
100.	Frog		
	Organs in situ (dissection)	1	
	Alimentary canal	1	
	Venous System	1	
	Arterial system	1	
	Urinogenital system (Male and Female)	1	
	Brain - different views and parts	1	
	Nervous system	1	
	Skeletal system	1	
	Heart and its structure	1	
	Heart T.S.	1	
	Eye	1	
	Ear	1	
	Buccal cavity	1	
	Life history	1	(14 in all)
101.	Various insects	1	
102.	Poisonous and non-poisonous snakes	1	
103.	Birds with various kinds of beaks and feet	1	
104.	Mammals of India - different kinds	1	

(1)	(3)	(4)
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V - Slides

Botany

105.*	Typical cell and content	1
106.	Root tip L.S. for mitosis (onion)	1
107.	Root T.S. & L.S. of dicot root	2
108.	Stem T.S. L.S. of dicot stem	2
109.	Leaf structure of typical leaf	1
110*	Chlamydomonas	2
111*	Spirogyra	2
112.	Agaricus T.S. of gill	2
113.	Moss L.S. of capsule	2
114.	Root nodule of leguminous plant	2
115.	Flower bud T.S.	1

Zoology

116*	Amoeba	2
117*	Blood of frog	2
118*	Blood of man	2
119.	Bone T.S. (frog)	2
120.	Earthworm T.S.	2
121*	Hydra-whole mount	1
122.	Hydra T.S.L.S.	1

VI - Skeletons & Models

123*	Skeleton Articulated (frog)	4
	Skull disarticulated (frog)	2 sets
124*	Frog's brain	1
125*	Bird's brain	1
126.	Human Skeleton (Plastic Model)	1

* May be improvised.

D. Items Common for Physics, Chemistry and Biology Experiments

S. No.	Name of Article	Quantity (Essential)
(1)	(2)	(3)

Chemicals

1.	Acid, hydrochloric pure	5 kg.
2.	Acid, nitric pure	2 kg.
3.	Acid, sulphuric pure	5 kg.
4.	Acid, sulphuric commercial	10 kg.
5.	Acid, glacial acetic	500 gm.
6.	Alum (potash) crystalline	1 kg.
7.	Ammonium carbonate	500 gm.
8.	Ammonium chloride	2 kg.
9.	Ammonium dichromate	250 gm.
10.	Ammonium hydroxide	1 kg.
11.	Ammonium sulphate	250 gm.
12.	Ammonium nitrate	250 gm.
13.	Barium chloride, crystal	100 gm.
14.	Barium nitrate	100 gm.
15.	Bleaching powder	500 gm.
16.	Bone charcoal	100 gm.
17.	Borax pure	500 gm.
18.	Boric acid	250 gm.
19.	Calcium carbonate (marble chips)	5 kg.
20.	Calcium chloride, granulated pure	1 kg.
21.	Calcium hydroxide	2 kg.
22.	Calcium oxide (good quality lime)	2 kg.



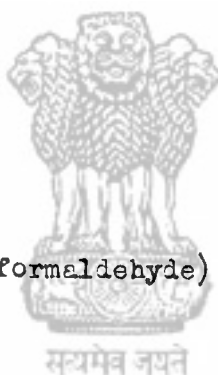
(1)	(2)	(3)
23.	Calcium sulphate (Plaster of Paris)	2 kg.
24.	Campher	50 gm.
25.	Carbon disulphide	1 kg.
26.	Chalk precipitated	500 gm.
27.	Cobalt nitrate, crystal	100 gm.
28.	Copper foil, thin	250 gm.
29.	Copper turnings	1 kg.
30.	Copper oxide, powdered	50 gm.
31.	Copper carbonate	100 gm.
32.	Copper sulphate, crystal	2 kg.
33.	Ether	500 gm.
34.	Glycerine	1 kg.
35.	Iron fillings, coarse	1 kg.
36.	Iron filling, fine and clean	500 gm.
37.	Iron chloride, ferric	200 gm.
38.	Iron oxide, ferric	200 gm.
39.	Iron sulphate	1 kg.
40.	Lead shots	1 kg.
41.	Lead nitrate	500 gm.
42.	Litmus granules	100 gm.
43.	Lead carbonate	200 gm.
44.	Lead oxide (litharage)	250 gm.
45.	Magnesium powder	50 gm.
46.	Magnesium ribbon	300 gm.
47.	Magnesium sulphate	500 gm.
48.	Magnesium chloride	250 gm.

(1)	(2)	(3)
49.	Manganese dioxide	2 kg
50.	Mercuric oxide, red	500 gm.
51.	Mercuric sulphate	250 gm.
52.	Mercury	4 kg.
53.	Methyl orange, dry	20 gm.
54.	Paraffin	1 kg
55.	Phenolphthalein	20 gm.
56.	Phosphorus, red	20 gm.
57.	Phosphorus, yellow	100 gm.
58.	Potassium bromide	250 gm.
59.	Potassium chlorate	1 kg.
60.	Potassium chloride	250 gm.
61.	Potassium dichromate	500 gm.
62.	Potassium hydroxide, pellets	1 kg.
63.	Potassium nitrate, crystal	1 kg.
64.	Potassium iodide	100 gm.
65.	Potassium permanganate	500 gm.
66.	Potassium sulphate	200 gm.
67.	Pyrogallol, crystal	50 gm.
68.	Silver nitrate	100 gm.
69.	Sodium metal	100 gm.
70.	Potassium metal	100 gm.
71.	Sodium bicarbonate	1 kg.
72.	Sodium carbonate	1 kg.
73.	Sodium chloride	4 kg.
74.	Sodium hydroxide	2 kg.
75.	Sodium nitrate	500 gm.

(1)	(2)	(3)
76.	Sodium nitrite	500 gm.
77.	Sodium sulphate	500 gm.
78.	Sodium thio-sulphate (hypo)	1 kg.
79.	Sulphur flower	100 gm.
80.	Sulphur roll	2 kg.
81.	Turpentine Oil .	5 litre
82.	Wool-glass (fine)	50 gm.
83.	Wool-Steel	250 gm.
84.	Zinc dust	500 gm.
85.	Zinc granulated	2 kg.
86.	Zinc sulphate	100 gm.
87.	Zinc carbonate	200 gm.
88.	Zinc Oxide	100 gm.
89.	Graphite	100 gm.
90.	Acid oxalic	250 gm.
91.	Lamp black	50 gm.
92.	Iodine resublimed	50 gm.
93.	Bromine	25 gm.
94.	Citric acid	50 gm.
95.	Tartaric acid	50 gm.
96.	Ethyl Alcohol	500 gm.
97.	Caloriform	500 gm.
98.	Iodoform	100 gm.
99.	Iron sulphide	1 kg.
100.	Mercuric sulphide	200 gm.
101.	Sodium silicate	1 kg.



(1)	(2)	(3)
102.	Antimony powder	1 kg.
103.	Ores of metals	1 set
104.	Fluorescein	50 gm.
105.	Lycopodium powder	10 gm.
106.	Starch	50 gm.
107.	Glucose	200 gm.
108.	Lead acetate	200 gm.
109.	A set of metal specimen	1 set
110.	Rectified spirit	5 litre
111.	Canada balsam	100 gm.
112.	Iodine crystals	100 gm.
113.	Mercuric chloride	250 gm.
114.	Agar agar shreds	200 gm.
115.	Formali (commercial formaldehyde)	5 litres
116.	Glove oil	100 cc. —
117.	Xylol	500 gm.
118.	Cobalt chloride	200 gm.
119.	Paraffin wax commercial	20 Kg.
120.	Eosin	10 gm.
121.	Methylene blue	5 gm.

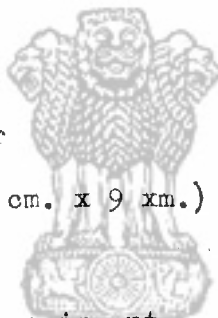


Tools

1.	Pliers, assorted	3
2.	Screw drivers, assorted	4
3.	Hammers, assorted	3
4.	Files, assorted	4
5.	Chisels, assorted	3

(1)	(2)	(3)
6.	Hand drill	1
7.	Bench vice, 10 cm. gap	1
8.	Grinder	1
9.	Metal cutting saw with spare blades (Hacksaw)	1
10.	Plane, medium size	1
11.	Nail puller	1
12.	Soldering iron with a set of bits (75 watts) (provided electricity exists)	1
13.	Metal Sledge	1
14.	Glass cutting pencil, simple	1
15.	Flat file 15 cm.	4
16.	Triangular file	2
17.	Saw (set of three)	1 set
<u>Audio-visual Aids</u>		
18.	Slide-cum-film strip projector	1
19.	Screen adjustable on stand	1
20.	Epidiascope (desirable)	1
<u>Miscellaneous</u>		
1.	Grease	2 kg.
2.	Insulating tape, roll	1
3.	Lead shots (assorted)	1 kg.
4.	Bucket (Galvanised)	3
5.	Scissors - medium and large size	1 each
6.	Inelastic cotton-thread reel	6
7.	Wooden blocks, assorted	48
8.	Wooden screens (to screen heat radiation)	6
9.	Candles, medium size	2 pkts.
10.	Brushes for cleaning glasswares	24

(1)	(2)	(3)
11.	Laboratory-trough (metallic)	4
12.	Drawing pins	1 pkt.
13.	Al-pins	200 gm.
14.	Emery paper, assorted	12
15.	Sand paper, assorted	24
16.	Trey, enamelled (medium size)	8
17.	Oilstove	4
18.	Electric heater	2
19.	Pneumatic trough iron (25 x 10 cm.)	12
20.	Knife	2
21.	Lamp chimney	4
22.	Cork borer sharpener	2
23.	Porcelain tiles (9 cm. x 9 cm.)	12
24.	First Aid kit	1
25.	Fire extinguishing equipment including bucket etc.	one set



Tools and Implements required for Workshops attached to
High Schools

S. No.	Description of tool	Quantity
(1)	(2)	(3)
B 1.	Hammers ball pein 8 oz.	2
2.	Hammers cross pein 8 oz.	2
3.	Hammers cross pein 4 oz.	2
4.	Hammer claw	1
5.	Screw driver heavy duty 12"	1
6.	Screw driver light duty 8"	2
7.	Screw radio repairers thin 6" with insulated blade	2
8.	Screw driver (watch makers set of 3)	1 set
9.	Pliers combination Mechanics 6"	3
10.	Pliers long tapered nose 6"	2
11.	Pliers needle nose round 4"	2
12.	Cutting pliers 6"	2
13.	Adjustable crescent wrench 10"	1
14.	Adjustable crescent wrench 4"	1
B 15.	Pipe wrenches 10"	1 (desirable)
B 16.	Double ended spanners whitworth sizes 1/8" to 3/8"	1 set
17.	Hacksaw frame (hand) 12" with 24 blades - 12" x 1/2" x 28 teeth	2
18.	Fretsaw frame (wood) with blades	1
19.	Panel saw wood 20"	1
20.	Tenon saw 12"	1
21.	Key hole saw adjustable	2
22.	Block plane metal 6" - 2" blade	2
23.	Smoothing plane 10" - 2" blade	1

S. No.	(2)	(3)
24.	Side plane 6"	1
25.	Chisels wood 1/2, 1/2", 3/4" 1"	2 each
26.	3/8" cold chisels metal cutting	3
27.	Hand drilling machine geared capacity 1/4" drill	2
28.	Twist drill bits parallel shank 1/16", 3/32", 1/8", 5/32", 3/16", 7/32" and 1/4"	1 set
29.	Carborundum sharpening stone 6" x 2" (one side medium other side fine)	2
30.	Sheet Metal Snipes (cutter or shears) 3" cut	2
31.	Scissors ordinary 10"	1
32.	Scissors small pointed	1
33.	Tweezers 6"	2
34.	Centre Punch (Small)	3
35.	Tweezers 4"	2
B 36.	Crow bar small 24" Carbon Steel	1
37.	Clue pot double walled	1
38.	Glass cutting pencil (diamond)	1
B 39.	Circular washer cutter for leather, plywood, cardboard etc.	1
B 40.	Hand driven (geared) bench grinding stone	1
41.	(a) Soldering iron (electric where supply available)	2
or		
	(b) Burner where electricity is not available	1
42.	Rosin cored solder wire	1 Lb.
43.	Fluxite Soldering paste	1 tin.
44.	Half Round wood rasp 10 or 12"	1
45.	Flat Bastered file 10"	1
46.	Half Round file 6" (fine & medium)	2
47.	Triangular file 4" (fine & rough)	2

(1)	(2)	(3)
	48. Round file 4" (medium and rough)	2
	49. Assorted needle files 16	4
	50. Sheetmetal workers dividers	2
	51. Wall Boards for tools	2
	52. Work table heavy size 6' x 1½ (or as according to space)	1
B	53. Carpenters vice 6" (to be fitted on work table)	1
	54. Bench fitters vice 2" jaw (to be fitted on work table)	2
	55. Jack knife	1
	56. Tin opener	1
	57. Leather punches set of 3	1 set
	58. Ratchet brace carpenters with cutter bits	1
B	59. Hand vice small	1
	60. 'C' clamps - 4"	2
	61. Scriber steel	2
	62. File handles	6
	63. Wood mallet	2
	64. Try squares 6"	2
B	65. Slide Bevel	1
B	66. Pin vice	1
	67. Oil can (small)	2
B	68. Carpenter clamp 2½"	1
B	69. Multimeter smaller or minor (with 4 voltage and 3 or 4 ampere range A.C. and D.C.)	1 (desirable)
	70. Folding rule carpenters 24"	1
	71. Bevel Point skiving knife	1
	72. Archimedian drill with set of bits for fine holes or watch-maker drills	1

Notes:-

- (i) Items marked 'B' may be purchased if adequate funds are available.
- (ii) The items mentioned in the list would also be adequate for the workshops attached to Higher Secondary Schools.
- (iii) Work-shop tools are strongly recommended for Middle Schools, if funds are available.

Equipment required for providing practical instruction in Physics in the B.Sc. Degree Course.

GENERAL LABORATORY EQUIPMENT

Sl. No.	Particulars of Equipment.	Number required	For a batch of 40 students	Category A-to be obtained for indigenous sources B-to be imported
1.	2.		3.	4.
1.	Balance (Physical) Balances (Analytical)		6	A
2.	Weight Boxes (Analytical)		6	A
3.	Standard Weight Box		1	A
4.	Balances (Gross)		1	A
5.	Spring balances		3	A
6.	$\frac{1}{2}$ K.G. Weight		2 doz.	A
7.	Bottles (Glass) 1 lb.		1 doz.	A
8.	Beakers. 500 cc. 250 cc. 100 cc. 50 cc.		36	A
9.	Burners (Bunsen)		18	A
10.	Iron stands with clamps		36	A
11.	Blow-lamp-Burner		1	A
12.	Corks (Assorted). Rubber stoppers Rubber tubings		6 grs.	A
13.	Tripod stands		2 doz.	A
14.	Foot blowers		2	A

1.	2.	3.	4.
15. Flasks (flat bottom):			
500 cc.		24	A
250 cc.		24	A
16. Cork Borer machines with 2 or 3 borers		1 set	A
17. Cork Press		1	A
18. Calipers (Micrometer)		6	A
19. Calipers (Vernier)		8	A
20. Cathotometer (small size)		3	A
21. Telescopes mounted on stands		10	A
22. Travelling microscope		10	A
23. Metre Scales		2 doz.	A
24. Measuring Tapes:			
1.50 ft. & cm.		3	A
2.100 "		3	A
3.6 "/2 Meter		3	A
25. Spherometers		10	A
26. Glass blocks		18	A
27. Stop Watches Stop Clocks		18	A
28. Archimedes pump		1	A
29. Fortin's barometer		1	A
30. Aneroid barometer		1	A
31. Specific gravity bottles		4 doz.	A
32. Graduated cyliners		6	A

1.	2.	3.	4.
33.	Weight Thermometers	10	A
34.	Slotted weight 50 gram each	3 doz.	A
35.	Glass Capillaries of various diameters	1 lb.	A
36.	Glass tubes	10 lbs.	A
37.	Chest of ordinary tolls various diameters	1	A
38.	Set of Pulleys	18	A
39.	Model of Submarine	1	A
40.	A hydrostatic balance	1	A
41.	A simple gyroscope	1	A
42.	Hydrometers	6	A
43.	Lactometers	2	A
44.	Constant level tanks	6	A
45.	Portraits of Physicists	1 set	A
46.	Small adjustable tables	2	A
47.	Drawing Board	6	A
48.	Apparatus for parallelogram Law of forces	4	A
49.	Small Workshop with tools	1 set	A
50.	Rubber stoppers	2 doz. of various sizes.	A
51.	Rubber tubings	50 metres ordinary 20 metres pressure tubing	A

1.	2.	3.	4.
<u>PROPERTIES OF MATTER</u>			
1. Young's modulus		4	A
2. "Y" by bending with optical lever & telescope		4	A
3. η by Statistical method apparatus		4	A
4. η by Dynamical method apparatus		4	A
5. Maxwell's needle		4	A
6. Spiral Spring		4	A
7. Bar Pendulum		3	A
8. Kater's pendulum		3	A
9. Fly SWheel for M.I.		4	A
10. Jaeger's apparatus for surface tension		4	A
11. Apparatus for determining Coef of viscosity of water by capillary flow		4	A
12. Searle's Apparatus for γ		4	A
13. Surface tension detachment method		4	A
14. Triple beam balance		1	A
15. Simple Pendulum		6	A
16. Coefficient of Friction Apparatus		4	A

1.	2.	3.	4.
<u>OPTICS</u>			
1. Holder lens and mirror		12	A
2. Telescope Clamps		10	A
3. Hartles Optical Disc		1	A
4. Illuminator for above		1	A
5. Convex and Concave mirrors		18	A
6. Convex & Concave lenses with various focal lengths		48	A
7. Reading lenses		4	A
8. Optical benches (Double bar)		8	A
9. Biprism		4	A
10. Optical bench for advanced work		2	A
11. Diffraction gratings		4	A
12. Lummer Brodhun Photometers		3	A
13. Incondenent tungesten lamp with filamont		3	A
14. Crossed replica grating		1	A
15. Reflection replica grating		3	A
16. Direct Vision Spectroscope		1	A
17. Spectrometers		8	A
18. Sodium Lamp (Large)		2	A
19. Spectrum tubes		4	A
20. Prisms (Extra dense Flint)		4	A

1.	2.	3.	4.
21. Prism crown glass		4	A
22. Wave length charts		2	A
23. New-ton's rings App.		4	A
24. Polarimeters		3	A
25. Nicol Prism		2	A
26. Calcite Crystals		2	A
27. Sextants		4	A
28. Epidiascope		1	A
29. 16 mm. projector (agfa)		1	A
30. Mercury vapour lamps and choke		2	A
31. Bunsen's photometer		4	A
32. Neon Lamps		3	A
33. Total internal reflection Apparatus using air		3	A
34. Lloyd's mirror		3	A
35. Glass Tanks 2" x 2" x 2"		10	A
36. Adjustable slit for resolving power of telescope		3	A
37. A pair of polaroids		1	A
38. Hollow prisms		6	A

1.	2.	3.	4.
<u>HEAT</u>			
1. Thermometers various types and ranges	24	A	
2. Boyle's law apparatus	3	A	
3. Hypsometer	4	A	
4. Wet & Dry bulb Hydrometer	3	A	
5. Metallic thermometer.	1	A	
6. Air Thermometers (Constant Vol.)	4	A	
7. Linear Expansion apparatus (Optical Lever)	4	A	
8. Weight Thermometers	6	A	
9. Ingenhouse apparatus (for Conductivity)	1	A	
10. Searle's Conductivity apparatus	3	A	
11. Leslie's Cube	1	A	
12. Crocks Radiometer	1	A	
13. Molecular motion Demonstration apparatus	1	B	
14. Mechanical Equipment of heat (Searle)	3	A	
15. Double Walled calorimeters for specific heat	12	A	
16. J. (Electrical) apparatus	4	A	
17. Continuous flow calorimeter	3	A	
18. Clement & Desorme's Apparatus	3	B	

1.	2.	3.	4.
19. Steam Engine Model		1	A
20. Gas Engine Model		1	A
21. Thermopile		1	A
22. Thermocouples		3	A
23. Constant pressure air thermometer		4	A
24. Regnault's hygrometer		3	A
25. Callendar's revolving Drum apparatus		1	A
26. Forbe's apparatus		1	A
27. Pt. Resistance thermometer		1	A
28. Regnault's cal for specific heat		2	A
29. Bunsen's ice cal		2	A
30. Six's Maxi. & Minimum Thermometer		1	A
31. Stove		2	A
32. Electric heater		4	A
33. Ritchie's apparatus for emissive and absorptive powers		1	A
34. Lees and Charltons Conductivity apparatus		2	A
35. Glazebrook & Shaw's calorimeter		2	A
36. Wire Gauge 6"		12	A
37. Joule's Calorimeter		3	A
38. Daniell's hygrometer		3	A

1.	2.	3.	4.
<u>SOUND</u>			
1. Crova's Disc.		1	A
2. Sawarth toothed wheel		1	A
3. Manometric Flame with revolving mirror		1	A
4. Air pump with bell jar or bottle containing electric bell		1	A
5. Tuning forks		3 sets of eight.	A
6. Adjustable pitch tuning fork		4	A
7. Electrically maintained tuning Forks		2	A
8. Electrically-maintained bar		1	A
9. Sensitive Flame		1	A
10. Wave motion Apparatus		1	A
11. Traveleyan's rockers		1	A
12. Melde's Expt. Apparatus		4	A
13. Chladn's Plate apparatus		1	A
14. Kundt's tube apparatus		3	A
15. Quinke's Interference tubes		1	A
16. Accoustic Oscillograph		1	A
17. Sonometers		4	A
18. Siren Disc.		1	A
19. Singing flame apparatus		1	A

1.	2.	3.	4.
20. Organ pipe		1 set	A
21. Cathode-Ray- Oscillograph		1	A
22. Dynamic microphone		2	B
23. Dynamic Louds - speaker		2	A
24. Revolving mirror		1	A
25. Sound Lens		1	A
26. Model of Ear		1	A
27. Resonance Tube Apparatus		3 sets	A
28. Stroboscopic disc.		2	A
29. Falling plate Apparatus		3	A
30. Apparatus for demon- stration of Inter- ference by ripples		1	A



सत्यमेव जयते

1.	2.	3	4.
<u>ELECTRICITY AND MAGNETISM</u>			
1. Arago's magnetic - rotation Apparatus		1	A
2. Earth Inductor		2	A
3. Bar Magnets		12	A
4. Horse Shoe Magnets		6	A
5. Eclipse 4" Magnets		6	A
6. Permalloy Rod		1	A
7. Magnetic Compass			A
8. Deflection Magnetometers		4	A
9. Os-cillation Magnetometers		4	A
10. Compass needles		6	A
11. Apparatus for B-H Curve		2	A
12. Fluxmeter & Search coil		2	A
13. Winhurts Electrostatic machine		1	A
14. Quadrant Electro- meter		1	A
15. Bunsen cells		3	A
16. Dry batteries 15 volts		6	A
17. Daniel cells		4	A
18. Leclanche Cells		12	A
19. Lead storage cells 45 AH		12	A
20. Edison batteries (12 crates of 2 cells (each)		18	AA

1.	2.	3.	4.
21. Standard Cells		3.	A
22. Lead storage batteries in units of 3 cells		4 units	A
23. Acid battery Hydrometer		1	A
24. Battery Charger		1	A
25. Induction Coil		1	A
26. Barlow's Wheel		3	A
27. Electromagnetic Induction Apparatus		1	A
28. Demonstration Motor and Generator		1	A
29. Alternating current Demonstration apparatus		1	A
30. Step-down transformers (12 Volts) (60 VA)		12	A
31. Step up transformer 220/110		6	A
32. Choke Coil and Electrical Resonance apparatus		1	A
33. Leyden Jars		6	A
34. Neon Tubes		3	A
35. Air condensers		4	A
36. Mica Condensers		3	A
37. Various Inductance Coils		18	A
38. Mutual Inductance Coil		6	A
39. Photoelectric cells (gas fitted)		4	A
40. Photoelectric cells (vacuum)		4	A

1.	2.	3.	4.
41.	Photoelectric cells (Weston)	4	A
42.	Cooper Voltameters	4	A
43.	Tangent Galvanometers	8	A
44.	Helmbolts Gal	3	A
45.	Moving Coil reflecting Galvanometer Dead beat	4	B
46.	ballistic High Res. long period	4	A
47.	Galvanometers 3 button	6	A
48.	Galvanometers (Weston)	6	A
49.	Gavanometers - Portable pointer	3	A
50.	Galvanometers Lecture Table	1	A
51.	Telescope and scale	2	A
52.	Ammeters Range: 0-1.5 Volts	4	
	0-5 "	4	
	0-15 "	4	A
		2	
53.	Voltameters: 0-1.5 Volts	4	
	0-5 "	4	
	0-15 "	4	A
	0-150 "	2	
54.	Avometer (Minor)	2	A
55.	Avometer (Major)	2	A
56.	Millivoltmeters	2	A
57.	Milliameters 0-30 amp.	6	A
58.	A.C. Ammeters 0-5 amp:	6	A
59.	A.C. Voltmeters 0-6 V.	6	A

1.	2.	3.	4.
60.	Resistance Boxes. Dial type of various ranges	12	A
61.	Rheostats (tubular type of various ranges)	24	A
62.	Standard ohms. 2' each of 1, 2 5 & 10 ohms.	4 sets	A
63.	P.O. Box		
	(a) Plug type	4	A
	(b) Dial type	4	A
64.	Megohms	4	A
65.	Carvey Foster Bridge	4	A
66.	Kelvin Bridge (Student type)	2	A
67.	Wire Potentiometers 10 wires	4	A
68.	Students' Potentiometer	3	A
69.	Keys		
	(a) Sing Way Single contact	2 doz.	A
	(b) Short circuiting	2 doz.	A
	(c) Double contact	4 doz.	A
	(d) Two way keys	2 doz.	A
70.	Switches (single pole)		
	(a) single throw	4	
	(b) Double pole double throw	4	
	(c) Double pole double throw	4	A
	(d) Pinch type double pole double throw	4	
71.	Triode valves	3	A
72.	Ordinary Condensers	6	A

1.	2.	3.	4.
73. Mercury Cup Keys		6	A
74. Dip Circle (standard with pointed needle or rolling needle)		4	A
75. Electromagnetic Radiation chart		1	A
76. Spectrum Chart		1	A
77. Periodic table chart		1	A
78. Bichromate cells		2	A
79. Crompton Potentiometers		1	A
80. Steward and Gee's Galvanometer		1	A
81. Laplace's Apparatus for studying mag field due to a circular current		2	A
82. An A.C. Vibrator to verify laws of transverse vibrations		1	A
83. Divided Capacity		1	A
84. Electrophorus		1	A
85. Resistance wires constantan, Eureka, Mithro German silver, Manganin		1	H
86. Callendar and Griffiths's bridge		1	A
87. Diode		1	A
88. Triode		12	A
89. Resistance coils		12	A
90. Slide Wire bridge		8	A
91. X-ray Demonstration set with screen		1	A
92. Geissler's tubes		6	A

1.	2.	3.	4.
93. Combives Vibration and Oscillation Magnetometers		2	
94. Standard Inductor		2	A
95. Potential divider		2	A
96. Electromagnet		2	A
97. Conductivity Bridge		2	A
98. Conductivity Cell		2	A
99. Head Phone		2	A

LIST OF EQUIPMENT FOR M.Sc. PHYSICS

For a batch
of 25 stu-
dents

OPTICS

1. Hilger Constant Deviation wavelength Spectrometer with Accessories	1	A
2. Hilger Accessories for Visual and Photographic Spectrum Analysis	1 set	A or B
3. Hilger Art and Spark Outfit with accessories	1	A or B
4. Accessories for obtaining monochromatic light in the visible	1	A or B
5. Hilger Accessories for Ramon Effect to fit on constant Deviation wavelength Spectrometer	1 set	A or B
6. Hilger Accessories for the measurement of Wavelength	1 set	A or B

1.	2.	3.	4.
7. Hilger High Resolving Power Instruments			
(a) Michelson cum Fabry Perot Interferometer with accessories	1	A or B	
(b) Fabry Perot Etalons	2	A or B	
(c) Echelon Grating Glass	1	A or B	
(d) Lummer Gehrecks Plate	1	A	
(e) Extension mount to fit Hilger constant Deviation Spectrometer to take high resolving power instruments (b), (c) (d)	1	A or B	
(f) Accessories of Various types for (b), (c), (d), (e) Accurate Micrometer Eyepiece, Special Camera attachments, (Mounts, Special Electromagnet Etc.) To fit accessory bar	1 set	A or B	
8. Hilger Small Quartz Spectrograph with accessories (Cameras, Quartz lenses, Plates, Holders etc.)			
		A or B	
9. Optical Bench with various accessories for final adjustment (F.T.I. Make) (Precision Tools Instruments, I.T.I. England)			
	2	A	
10. Fresnel's Binmirror	2	A	
11. Fresnel's Binmirror	2	A	
12. Cathotometers	2	A	
13. Vernier Measuring Microscopes	4	A	
14. Large Reading Telescopes	4	A	
15. Spectrometer, Large Size 7½" diameter, with vernier const. of 10 seconds or 20 second. (Research Spectrometer)	6	A	

1.	2.	3.	4.
16. Polarization Spectrometer for experiments with Polarized light & to study reflection of light from metals		2	A
. Babinet's Compensator		1	A
18. Abbe Refractometer		1	A
19. Replica Diffraction Gratings (Plane) for Transmission		2 6 (ordinary)	A
20. Replica Diffraction Gratings (Plane) Reflexion Grating		2	A
21. Concave Diffraction Grating		2	A or B
22. A set of Diffraction Screens (St. wire, St. edge, Circular aperture, Circular obstacles etc.)		2 sets	A
23. Polarimeter		1	A
Prisms of different sizes, different dispersion		1 set	A
25. Monochrometer		1	B
26. Light Sources (Cadmium, Sodium Wotan Lamps; Mercury, Helium, Hydrogen, Neon)		1 each	A
27. Geissler Discharge Tubes (various types)		1 each	A
28. Miscellaneous other Accessories (Quartz Lens, Nicol, Prisms, Polaroids, Point-to-light, Straight filament Lamps etc., etc.)			A or B

1.	3.	4.
<u>ELECTRICITY & MAGNETISM.</u>		
1. Standard of Self Inductance ranges 1 Henry, 0.1H, 0.01H, 0.001H, 0.0001H (Make Hartman & Brawn or Cambridge Instrument Co.)	6	A
2. Standards of Mutual Inductance range 10 mH. 0.1mH (Hartman & Brawn or Cambridge Instrument Co.)	6	A
3. Condensers of various Capacitances Plug Type, Decade Type, Dial Type (H. Tinsley, Grandling Germany Make Dawe & Gambrell, English Make)	1 Dozen	A
4. Lamp & scale arrangement	6	A
5. Tinsley D'Arsonval Galvanometer Type 3038, with Different Values of resistings coil	6	A
6. Subdivided Megohm Boxes	6	A
7. Autotransformers (British Electric Resistance Co., 'BERCO' Make) Different output and different ratings of current	6	A
8. Bismuth Spirals (Hartman & Brawn Make)	2	A or B
9. Disappearing filament type optical Pyrometer (Hartman & Brawn Make)	2	A or B
10. Search Coil (W.G. Iye Make)	4	A
11. Vibration Galvanometer (Cambridge Instrument Co., or Tinsley Make)	1	A
12. Test Office Boxes, Plug Type (W.G. Iye Make)	1 dozen	A
13. Audio Frequency Oscillator (W.G. Iye) or (Cambridge Instru- ment Co. Make)	2	A

1.	2.	3.	4.
14. Induction Coils (George Maker Co.,) England		6	A
15. Wattmeters (Electro Dynamometer; Astatic-Two Type with Antiparallax mirror). Hartmen & Brawn Make) or (Cambridge Instrument Co.)		2	A
16. Standard Resistances (Different Values and ratings of current) Hartment & Brawn Make or Cambridge Instrument Co.,		4	A
17. Voltmeters AC/DC or AC and DC (i) Precision Type (Astatic Dynamometer Type with anti-parallax Mirror strip) Different ranges Hartman & Brawn Multi-range Instrument Make or Cambridge Instrument Co., or Matrimpex Hungery. (ii) For ordinary work (Different ranges) Hartmen & Brawn Make		6. 1 dozen	 A
18. Ammeters AC/DC or AC and DC (i) Precision Type (moving iron Astatic Dynamometer with antiparallax Mirror) Different ranges Multirange Instruments (ii) for ordinary work different ranges Hartman & Brawn Make or Cambridge Instrument Co. or Matrimpex Hungery		6	A
19. Milliammeters { Different range Microammeters { for well precision as well as ordinary work Hartmen & Brawn or Cambridge Instrument Co. Make		1 set	A
Millivoltmeters, Different ranges (For Precision as well as ordinary work)			

1.	2.	3.	4.
20.	Resistance Boxes (Different Ranges) Low Induction winding for work on A.C. and for work on D.C.W.G. Pye Make	24	A
21.	Decade Resistance (Different ranges) Grammel, England Croydon Precision Instrument, Eng. W. G. Pye Make Doran Instruments, England	2	A
22.	Rheostats Various ranges, Various ratings of currents Various sizes (BERCO Make) or Standard Scientific Inst. Co. Madras or Andhra Scientific Co.	10	A
23.	Head of Phones (W.G. Pye Make)	6	A
24.	Buzzers (Audio Frequency source) W. G. Pye Make	3	A
25.	Wulf Bifillar (Quartz Bow string) Electrometer with various accessories (Ganthor & Tegetmeyer Make German)	2	B
26.	Quadrant Electrometer (Dolezalek Type) W.G. Pye Make or Cambridge Instrument Company.	2	B
27.	Electromagnet to give about 10,000 oersteds W.G. Pye Make	1	A
28.	Campell Mutual Inductance Box (various ranges to cover Micro & Millihenries) Cambridge Inst. Co.	3	A
29.	Carey Foster Auxiliary Box Cambridge Inst. Co.	1	A
30.	Low Inductance Radio Box Cambridge Inst. Co.	2	A
31.	Low Induction Decade Resistance various Ranges (Cambridge Inst. Co.)	2	A

1.	2.	3.	4.
32. Universal Bridge (Cambridge Inst. Co.)		1	A
33. Precision Capacity Bridge Cambridge Instrument Co.		2	A
34. A.C. Potentiometer (Cambridge Inst. Co.)		1	A
35. Slide Wire Potentiometer (Cambridge Instrument Co., or W. G. Pye Co.)		1	A
36. Electrically Maintained Tuning Fork Andhra Scientific or Standard Scientific Madras or W.G. Pye Co.		6	A
37. Friction Driven Stroboscopic Disc Arrangement (Cenco, Chicago U.S.A.)		1	A
38. Low Tension Exide Cell		1	A
39. High tension Exide Cell (Wet as well dry type)		1	A
40. Miscellaneous Accessories (Plug Keys, Charge, Discharge Keys, wires, Connections, Leclanche Cells etc.)		8 each	A
41. Multipurpose Test meter (Avometer Model 6 Universal, England Make)		2	A
42. Neon Flash Lamp (Coiled Coil Type)		4	A or B
43. Anchor Ring (Andhra Scientific Co.)		2	A
44. Suspended Magnet Magnetometer (Suspension Type) Standard Sc Madras		2	A
45. Western Galvanometers for ordinary work		6	A
46. H. & B. Pointer Fluxmeter		1	A or B

1.	2.	3.	4.
<u>VACUUM EQUIPMENT:</u>			
1. Vacuum Pump to give 0.002 mm. of Hg.-Pfeiffer, German Make	2	A	
2. Two stage Rontgen Pump to give 10-5 mm of Hg. - Pfeiffer, German Make	1	A	
3. Combined Vacuum Pump and Blower (to give 0.002 mm. of Hg. or 7 lbs/Sq. inch. pressure)	1	A	
4. Three stage Mercury Diffusion Pump	1	A	
5. Oil Diffusion pump	1	A	
6. McLeod Gauge	2	A	
7. Pirani Gauge	1	A	
8. U. Tube Manometers	6	A	
9. Various other accessories (such as Vacuum grease (Apiezon) Vacuum oil ground rail and female joints, pressure tubing etc.		A	
10. Vacuum Tester	2	A	
<u>ATOMIC PHYSICS & GENERAL ELECTRONIC EQUIPMENT</u>			
1. Milliken's Apparatus for Determination of 'E'	2	A	
2. Braun's Tube determination of e/m Complete Cathod Ray Tube and Power Pack	1	A	
3. Photoelectric cell	3	B	
4. ElectroScopie for measurement of B-Rays	2	A	
5. Geiger counter Unit for measurement of Radioactivity	1	A	

1.	2.	3.	4.
6. Cathod Ray Oscillograph		2	A
7. Valves (Triode, Tetrodes, Pentodes etc.)		2 each	A
8. Radiation count Rate Meter (Philips)		1	A
9. Miscellaneous accessories in Electronics (Sockets, Valve Brass, Condensers, Grid Leaks etc., etc.)			A

MISCELLANEOUS ARTICLES (GENERAL) FOR THE LABORATORY

1. Beakers,		2 doz.	A
2. Tape		2	
3. Callipers		3	
4. Mortar and pestle		2	L
5. String Electrometer		1	A
6. Battery 5 volts, and 2 volts. Exide		12 each	A
7. P. O. Box		6	A
8. Resistance Box		12	A
9. Resistance box Decade		6	A
10. Resistance Megohm		6	A
11. Resistance Decade Megohm		6	L
12. Rheostats		12	A
13. Search coil		4	L
14. Shunts Universal		6	A
15. Solenoid Inductor		4	A

1.	2.	3.	4.
16. Scale lamp		6 ⁵	A
17. Valve Base		6	A
18. Voltmeter A.C.		5	A
19. Voltmeter D.C.		6	A
20. Voltmeter D.C. (Milli)		6	A
21. Voltmeter D.C. (Milli)		6	A
22. Wattmeter (ordinary)		2	A
23. Wattmeter, Electro-dynamometer G.E.C.		1	A
24. Fleming's Commutator		4	A
25. Battery charger		1	A
26. Auto transformer		1	A
27. Transformer of different ranges		1	A
28. Vibration Galvanometer fixed frequency Camb		2	A
29. Vibration Galvanometer adjustable frequency Audio frequency Generator (Advance)		2	A
30. Electrically Maintained Tuning Fork		2	A
31. Condenser (milliifarad)		1 set	A
32. Alpha & Beta ray Electroscope		1	A
33. Photo voltaic cell		2	B
34. Photo conductive cell		2	B
35. Photo Sensitive Cell		2	B
36. Searl's Magnetometer with magnet		2	A

1.	2.	3.	4.
37. Ammeter A.C.		6	A
38. Ammeter D.C.		6	A
39. Milliammeter D.C.		6	A
40. Microammeter D.C.		6	A
41. Inductometer		1	A
42. Avometer		1	A
43. Anchor ring		2	A
44. Bismuth Spiral		2	A
45. Buzzer		6	A
46. Condenser (fixed)		6	A
47. Condenser (Decade)		6	A
48. Compensating coil		4	A
49. Cell standard		4	A
50. Commutator (Metal)		4	A
51. Commutator (Mercury)		4	A
52. Electromagnet EYE		1	A
53. Frequency meter		2	A
54. Fluxometer		1	B
55. Ballistic Galvanometer		4	A
56. Hibbert Magnetic Standard		1	B
57. Head phone		4	A
58. Inductance self (fixed)		2	A
59. Inductance self (variable)		2	A
60. Inductance mutual		2	A



1.	2.	3.	4.
61. I-H Curve Set		1	A
62. Induction coil		1	A
63. Millikans oil drop Apparatus			A
64. Millikans oil drop Apparatus			A
65. Millikans apparatus Atomiser			A
66. Neon flash lamp			
67. Broun's tube			B
68. Quadrant Electrometer			B
69. Comp bell Mutual Inductometer			A
70. Potentiometer			A
71. Pyrometer			A
72. Soldering material			A
73. Soldering flux			A
74. Post Office racks			A
75. Steel plate (thick aluminium plate)			A
76. Volt meters			A
77. Ammeters			A
78. Bulb Indicators			A
79. Cloud chambers with electronic control and pump			A
80. Reprojection unit			A
81. Binocular Microscope			A
82. Exposed Nuclear emulsion plate (Study on Proton tracks)			B
83. Immersion Oils			A or B
84. Miscellaneous			A or B

EQUIPMENT REQUIRED FOR PROVIDING PRACTICAL INSTRUCTION IN CHEMISTRY
IN THE B.SC. DEGREE COURSE (FOR 40 STUDENTS).

1.	2.	3.	4.
<u>PHYSICAL CHEMISTRY APPARATUS</u>			
1. Beckman Thermometer	4	B	
2. Freezing Point tubes	12	B	
3. Landsberger Boiling point apparatus	4	B	
4. Cottrells Apparatus B.P.	4	B	
5. Bottle Shaker	1	A	
6. Thermostat 12" by 16"	2	A	
7. Conductivity Apparatus set	4	A or B	
8. E.M.F. Apparatus Sets	4	A	
9. Bomb Calorimeter	1	A	
10. Copper Calorimeter	4	A	
11. Polarimeter	1	A	
12. Refractometer	1	A	
<u>LABORATORY EQUIPMENT</u>			
1. Burette Stand	50	A	
2. Funnel Stand 5"	100	A	
3. Mortar & Pestle 15 cm.	50	A	
4. Test Tube Stand	50	A	
5. Porcelain Tile	50	A	
6. Pipe Clay Triangle	120	A	
7. Crucible Tongs	50	A	
8. Tripod stand	50	A	
9. Liebig's Condenser	50	A	
10. Air condenser	50	A	


1.	2.	3.	4.
11. Thermometre 360		18	A
12. Thermometre (various sizes)		24	A
13. Water bath with copper rings		24	A
14. Sand bath		50	A
15. Stands assorted		60	A
16. Clamps with boss head		120	A
17. Steam oven 20" x 20"		5	A
18. Hot air oven 20" x 20"		5	A
19. Masons apparatus for melting point		3	A or B
20. Burners		80	A
21. Cork presser		1	A
22. Cork borers sets		5	A
23. First Aid Kit		1	A
24. Blast Lamp		12	A
25. Techlu Burners		24	A
26. Tool set		1	A
27. Balance with weight box		24	A
28. Common Balance		2	A
29. Distilled waterplant or Demineraliser		1	A
30. Air compressor		1	A
31. Epidiascope		1	A
32. File Triangular		10	A

1.	2.	3.	4.
33.	File bound	10	A
34.	Test Tube holders	40	A
35.	Fish Tail Burners	20	A
<u>SPECIAL LABORATORY GLASSWARE</u>			
1.	Porcelain basin 10 cm.	50	A
2.	-do- 20 cm.	40	A
3.	Winchester Bottle 3 lit.	100	A
4.	Burette 50 cm.	50	A
5.	Crucible + lid	60	A
7.	Sintered Crucible G-4 with filtering set	50	A
8.	Measuring Cylinder 100 cc.	24	B
9.	Measuring 500 cc. Cylinders	10	A
11.	-do- 250 cc.	24	A
12.	Desicator dia 20 cc.	50	A
13.	Wash bottle 1000 cc.	50	A
14.	Wash Gac	6	A
15.	Vacuum desicator	2	A
16.	Hot air blower	1	A
17.	Conical Flask 100 cc.	50	A
18.	-do- 250 cc.	150	A
19.	Measuring Flask 100 cc.	100	A
20.	-do- 250 cc.	100	A
21.	--do- 500 cc.	50	A



1.	2.	3.	4.
22.	Buckner funnel 250 cc.	50	A
23.	Distilling flask with fine tube 50 cc.	50	A
24.	-do- 50 cc.	50	A
25.	-do- 25 cc.	24	A
26.	Distilling tubes 25 cc.	120	A
27.	Separating funnel 100 cc.	24	A
28.	-do- 50 cc.	24	A
29.	Measuring Flask		A
30.	-do- 1 lit.	24	A
31.	Through Pneumatic	10	A
32.	Pipette 20 cc.	100	A
33.	-do- 10 cc.	50	A
34.	-do- 50 cc.	2	A
35.	-do- 100 cc.	2	A
36.	Watch Glass 10 cc.	100	A
37.	-do- 15 cc.	100	A
38.	Weighing bottle medium	50	A
39.	Kipps apparatus 1 lit.	8	A
40.	Reagent bottles (narrow mouth) 250 cc.	800	A
41.	Reagent bottles (wide mouth) 250 cc.	500	A
42.	Solution bottles (narrow mouth) 250 cc.	100	A
43.	-do- 100 cc.	100	A

1.	2.	3.	4.
<u>ROUTINE GLASSWARE</u>			
1. Beaker	100 cc.	50	A
2. -do-	250 cc.	150	A
3. -do-	400 cc.	100	A
4. -do-	1000 cc.	15	A
5. Round bottom flask	500 cc.	100	A
6. -do-	250 cc.	100	A
7. -do-	100 cc.	100	A
8. -do-	25 cc.	50	A
9. Funnel	3"	100	A
10. Funnel	2½"	100	A
11. Funnel	5"	10	A
12. Glass Rod		20 kg.	A
13. Glass Tube		20 kg.	A
14. Boiling Test Tubes	6 x 1	20 gross	A
15. Test Tube	6 x 5/8	50 gross	A
16. Hard Glass Test Tube	4 x ½	20	A
<u>MISCELLANEOUS</u>			
1. Horn Spatula	15 cm.	100	A
2. Nickel Spatula		24	A
3. Rubber tubing yds.		200	A
4. Wire gauze (Asbestos cement)		150	A
5. Asbestos pad		100	A
6. Chemical Charts		1 set each	A

1.	2.	3.	4.
<u>MISCELLANEOUS CONSUMABLE ARTICLES</u>			
1. Brushes for Test tube		24	A
2. Brushes for Burettes		12	A
3. Cork velvet for flasks		2 gr.	A
4. Corks velvet for test tubes		2 gr.	A
5. Rubber cork for flasks		36	A
6. Charcoal Borers		1 gr.	A
7. Camel Hair brushes		24	A
8. Filter paper 12 cm. Grav		10 pkt.	A
9. Filter paper sheets		1 ream	A
<div style="text-align: center;">  <p>Unit of 2 batches of <u>16 students</u></p> </div>			
<u>M.Sc. Chemistry</u>			
1. Sintered Glass Crucible G3, G4		40	A
2. Whatman filter papers - No. 1, 40, 541.542, 41, 42			A
3. Incubator		1	A
4. Magnetic stirrer		6	A
5. Hot Electric plates		6	A
6. Muffle Furnace		1	A
7. Meker Burner			A
8. Crucible Furnace		2	A
9. Conical Flask - 500 ml. 250 ml. 100 ml. Gena and Pyrex			A
10. Steam-oven		3	A
11. Air Oven Ordinary & electric		2 each	A


1.	2.	3.	4.
12.	Electrical/Mechanical stirrer	3	A
13.	Vacuum pumps	2	A
14.	Apparatus complete Semi-Micro for estimating C & H	3 sets	A
15.	Apparatus complete Semi-Micro for estimating nitrogen	3 sets	A
16.	Apparatus complete Semi-Micro for estimating halogen & sulphur	3 sets	A
17.	Kjeldahes flask 150 cc.	2 dozen	A
18.	Kjeldachs head for above	6	A
19.	Zeisel's flask	1 dozen	A
20.	Gas bubbler small	2 dozen	A
21.	Combustion type	1 dozen	A
22.	Combustion tube sealed at the end	6	A
23.	Nickel Crucible with lid	6	A
24.	Platinum Crucible	2	A
25.	Platinum Wire and foil		A
26.	Big Beakers and bolt headed R. B. flasks	1 dozen each	A
27.	Quick fit glass joint apparatus - B-24-R.B.	24	A
28.	Conical flasks of different sizes	24	A
29.	Orinary & Double surface, condensers	6 each	A
30.	Thermometer - 360°	3 dozens	A
31.	-do- 110	3 dozens	A
32.	Filter pump	2 dozens	A
33.	Perceclain boat	1 dozens	A
34.	Distilling bends	12	A


1.	2.	3.	4.
<u>LIST OF APPARATUS FOR PHYSICAL CHEMISTRY (M.Sc.)</u>			
1. E.M.F. Set	3 sets	A	
2. (i) Potentiometer		A	
(ii) Galvanometers with lamp & scale arrangement		A	
(iii) Standard Cadmium Cell		A	
(iv) Battery (2 volts)		A	
(v) Electrode Vessels		A	
(vi) Hydrogen electrode Vessel (hilde brand Type)		B	
(vii) Connecting wires		A	
3. Conductivity Set	2 sets		
(i) Metre bridge		A	
(ii) Buzzer (J.C.)		A	
(iii) Resistance box (5 to 10 thousand ohms)		A	
(iv) Conductivity Cell with Platinum electrode		A	
(v) Thermostat		A	
(vi) Battery (2 Volts) connecting wires		A	
(vii) Head Phone		A	
4. Transport Number Set	2 sets		
(i) Two hitorf's tube with a U-tube for middle compartment		A	A
(ii) Resistance Box		A	
(iii) Milliametre		A	
(iv) Silver Electrode		A	
(v) Copper electrode		A	

1.	2.	3.	4.
5.	Victor Meyer Set	4 sets	A
6.	Dumas set	3 sets	A
7.	Landsberger Set for B.P. elevation	2 sets	
8.	Beckman F.B. Set	2 sets	B
9.	Surface Tension Set	2 sets	A
	(i) Stalgometre		
	(ii) Pyknometre or Sp. Gravity bottle		
10.	Viscosity Set	1 set	A
	(i) Ostwald Viscometre (six spare)		
	(ii) Thermostate having glass pan sides		
11.	Thermochemistry Set	2 sets	
	(i) Dewar's Flask or Thermo flask		
	(ii) Thermometer		
12.	Order of Reaction Set	3 sets	
	(i) Aspirator bottle fitted with a buret for Baryat soln		
	(ii) Thermostat		
	(iii) Pressure bottle		
13.	Partition co-efficient set	3 sets	A
14.	Polarimeter	1 set	A
15.	Refractometer	1 set	A
16.	Density Globes	1 set	A
17.	Colorimeter	1 set	A
18.	Fortin's Barometer with its case	1 set	A
19.	Vacuum dessicators	3 sets	A

1.	2.	3.	4.
20.	Hempel's gas burettes	1 set	A
21.	Hempel's gas pipetes	1 set	A
22.	Magnifying lens	4 sets	A
23.	Mercury distillation apparatus	1 set	A
24.	Semi-Micro analytical - balance with lamp & scale arrangement	1 set	A
25.	Universal torsion Viscometer	1 set	A
26.	Motors 1/6 H.P. (A.C.)	2 sets	A
27.	Microscope	1 set	A

Equipment required for providing practical instruction in Botany in the B.Sc. Degree Course.

		For a batch of 20 stu- dents	
 सत्यमेव जयते			
I. <u>Non-consumable</u>			
1.	Student Microscopes	24	A
2.	Dissecting Microscopes	24	A
3.	Binocular Microscope	2	A
4.	Research Microscope with Oil Immersion	1	A
5.	Demonstration Eyepiece (Double)	4	A
6.	Chemical balance with Wt. Boxes	2	A
7.	Microtome - Botany	1	A
8.	Microtome - Rocking	2	A

1.	2.	3.	4.
9. Paraffin bath		1	A
10. Micrometer Scale			A
Micrometer Stage		1	
Ocular		2	B
11. Camera Lucida		1	A
12. Dissection Boxes		2	A
13. Hand Lenses		24	A
14. Spirit Lamps		24	A
15. Centrifuge		1	A
16. Pan Balance		1	A
17. Tripod Stands		1 doz.	A
18. Claytriangles		1 doz.	A
19. Forceps long		1 doz.	A
			
<u>II. Equipment for Demonstration of Experiments in Plant Psychology such as:</u>			
1. Potometer			
2. Respirometer			
3. Auxanometer			
4. Clinostat and other equipment to demonstrate Osmosis, Imbibitional Pressure Ele. Leaf punch.		2 sets	A
<u>III. Ancillary Equipment</u>			
<u>Glassware:</u>			
1. Museum Jars		500 nos.	A
2. Bell Jars		10	A
3. Dropping bottles of different sizes		2 gross	A

1.	2.	3.	4.
4. Reagent bottles		1 gross	A
5. Measuring Jars of different Cap		4 sets	A
6. Enamel Trays (sizes)		4 doz.	A
7. Petri dishes (different sizes)		2 gross	A
8. Test Tubes		4 doz.	A
9. Funnels		2 doz.	A
10. Porcelain funnels		1 doz.	A
11. Pippettes		2 doz.	A
12. Burettes		1 doz.	A
13. Beakers		$\frac{1}{2}$ gross	A
14. Thermometers		$\frac{1}{2}$ doz.	A
15. Psstle & Mortar		6	A
16. Weighing bottles		1 doz.	A
17. Dessicators		$\frac{1}{2}$ doz.	A
18. Crucibles		1 doz.	A
19. Burners		1 doz.	A
20. Meter Scales		3	A
21. Glass Rods		5 lbs.	A
22. Funnel Stand		1 doz.	A
23. Cork Borers		2 sets	A
24. Cork Compressor Test Tube Stands		1 doz.	A



1.	2.	3.	4.
IV. <u>Herbarium, Botanical Garden and Museum Equipment</u>			
1. Show Cases		12	A
2. Vasculum		6	A
3. Secator		4	A
4. Life history Charts and Models for types prescribed		2 sets	A
5. Permanent Microscopic prepared slides of types prescribed		2 sets	A
6. Racks for dropping Bottles		24	A
7. Bot. Garden (500 sq.yards)			
8. Herbarium Steel		6	
Almirah			
9. Garden Tools		2 sets	
<u>Consumables per year</u>			
1. Slides		10 gross	
2. Cover hips		20 oz.	
3. Chemicals including Alcohols, Formaldehyde, Acids etc. Stains			

1.	2.	3.	4.
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Unit of 20
students

Requirements for Teaching Botany
to M.Sc. Classes - II Year Course

1. Compound microscope, triple nose-piece Oil Immersion	25 (for 5 teachers)	A
2. Compound microscopes, double nose-piece	5	A
3. Compound microscopes, quadruple nose-piece, phase- contrast	1	A
4. Binocular microscopes, stereoscopic	2	A
5. Dissecting microscopes, lens x 10	25	A
6. Microtome, rotary	3	A
7. " , sliding	1	A
8. " , knife-sharpener	1	A
9. Ovens, hot air, 40-100°C	4	A
10. Ovens, " " , 50-300°C	2	A
11. Autoclave, large	1	A
12. " , small	1	A
13. Hot Plates, Electrical, 50-60°C	4	A
14. Physical balances	2	A
15. Chemical "	2	A
16. Analytical "	6	A
17. Torsion "	2	A
18. Vacuum pump	2	A
19. Centrifuge, electrical	2	A
20. " , hand-operated	6	A

1.	2.	3.	4.
21. Waring blenders		3	A
22. Epidiascope		1	A
23. Slide projector, 35 mm.		1	A
24. Refrigerators		2	A or B
25. Peep-freeze		1	A
26. Physiology apparatus			A
27. Glassware, slides, coverslips			A
28. Chemicals			A
29. Prepared slides			A
30. Museum accessories			A
31. Botanical Garden			A
<u>Botany Common to Under-Graduate.</u>			
<u>Post-Graduate, etc., etc.</u>			
1. Demonstration Eye-piece			A
2. Camera Lucida			A
3. Electric Drier			A
4. Micrometers			A
5. Distillation apparatus			A
6. Typewriter			A
7. Exhaust pump			A

1.	2.	3.	4.
<u>Equipment required for providing practical instruction in Zoology in the B.Sc. Degree Course (for 20 students)</u>			
1. Students Microscopes	20		A
2. Research Microscope	1		A
3. Binocular Dissecting Microscope	1		A
4. Paraffin Embedding bath	1		A
5. Microtome	1		A
6. Apparatus (Hand lenses, Dissecting Instruments etc.)			A
7. Glass apparatus (Specimen Jars, specimen tubes, Coverglasses, Staining troughs, Pippettes, Reagent Bottles, Animal Containers)			A
8. Museum show cases			A
9. Museum specimens (representative of all groups)			A
10. Skeletons (representative of all groups)			A
11. Charts-Wall charts			A
12. Prepared slides (representative of all groups)			A
13. Epidiascope			A
14. Library			A
15. Chemicals: Alcohol, Spirit, Acetic Acid, Formalin, Picric Acid, Canada Balsam, Xylol, Haematoxylin, Eosin, Chloroform, etc.)			A

1.	2.	3.	4.
<u>LIST OF EQUIPMENTS FOR M. So. CLASSES</u> <u>IN ZOOLOGY.</u>		<u>For 16 stu-</u> <u>dents in each</u> <u>year</u>	
1. Leitz Microscopes	32	A	
2. Research Binaocular Microscopes	4	A	
3. Phase Contrast Microscopes	2	or B	
4. Dissecting Microscopes	32	A	
5. Binaocular Dissecting Microscopes.	6	A	
6. Microstome (Rotary)	2	A	
7. Thermostats	4	A	
8. Epidiascope	1	A	
9. Ovens	2	A	
10. Paraffin Embedding Table	4	A	
11. Micromitapulae or (Microdissector)	1	A	
12. Micrometer Eye-piece	16	A	
13. Stage Micrometer	2	A	
14. Pointer Eye-piece	3	A	
15. Double Demonstration Eye-piece	2	A	
16. Camera lucida	4	A	
17. Paraffin bath	2	A	
18. Distilling Still	1	A	
19. Incubators	2	A	
20. Centrifuge	1	A	

1.	2.	3.	4.
21. Freezing Microtome		1	A
22. Pumps (a) Vacuum pump		1	A
(b) Pressure pump		1	A
23. Microscope Lamps		32	A
24. Projector (Bell and Howel)		1	A
25. Tape Recorder		1	A
26. Camera (16 mm)		1	A
27. Binoculars		1	A
28. Panphot (with accessories) Linhof with accessories			
29. Microbalance		1	A
30. Balance Ordinary		1	A
31. Balance Ordinary		1	A
32. Weight Boxes		2	A
33. Demonstration Slides			
34. Rocking Microtome		2	A
35. Chemicals			A
36. Models and Charts			
37. Glass Wares			
38. Museum Specimen			
39. Miscellaneous			

LIST OF EQUIPMENT AND INSTRUMENTS REQUIRED FOR THE
VARIOUS CIVIL ENGINEERING LABORATORIES FOR DEGREE COURSES.

SYMBOLS

- A = Equipment indigenously available.
- B = Equipment that are not available from indigenous sources but technical institutions would be assigned the job for preparing proto type of such items.
- B₁ = Proto type Equipment that could be manufactured in the institutions itself, although indigenously available.
- C = Items of equipment that are not covered by (A) and (B) above and to be imported from countries other than Eastern European countries.
- C₁ = Items of equipment that are not covered by (A) and (B) above and to be imported from Eastern European countries.

SURVEY LABORATORY

सत्यमेव जयते

Item No.	Item and Specification.	Number required.	Category	Remarks.
1.		2.	3.	4.
1.	Engineers' chains with arrows. (20 m & 30 m)	30	A	
2.	Gunters' chains with arrows	1	A	
3.	Prismatic compass with stand	20	A	
4.	Surveyors' compass with stand	1	A	
5.	Plane tables complete with accessories (spirit level, plumb bob, trough compass, alidade metallic, stand for the plane table etc.)	20	A	
6.	Levels (Specified or equivalent):			
	a. Cookes reversible level with stand	1	C ₁	

1.	2.	3.	4.	5.
b. Watts Y-level with stand	1	C ₁		
c. Stanley's Dumpy level in box with stand	1	C ₁		
d. Wild Hearbrugg, Dumpy level with stand	1	C ₁		
e. C.T.S. tilting level (Cat. No. 5300-04) with stand	1	C ₁		
f. Wild Hearbrugg level No. 10 complete in case with stand	1	C ₁		
g. Kern Aaran Level with stand	1	C ₁		
h. I.O.P. and Dumpy levels	18	A		
7. Levelling Staves:				
a. Telescopic 4.25 m.	24	A		
b. Straight 3 m.	16	A		
8. Theodolites (specified or equivalent):				
a. Watts standard Vernier Theodolites reading to 20" with stand	8	A		
b. Glass circle theodolites reading to 30" or better.	12	C or A.		
9. Nautical and Box sextants	1 each.	A or C.		
10. Steel tapes (Chesterman's) 30 m. & 20 m.	12			
11. Metallic tapes (Chesterman's) 30 m. & 15 m.	25			
12. Miscellaneous equipment such as planimeter, pentagraphs, optical squares, cross-staves, ranging rods, survey plotting scales, Trough compasses, hand levels, Abney levels, Indian pattern clinometers, Extra bubble tubes spirit levels, Mallets, protractors, Ghat tracers, De-Lisles clinometers, uni-meters, globes, star charts, topographic sheets, line rangers, Barometers arial photographs, template punching machine, template material, Astronomical slides and sounding rods		A		
Celestial sphere model	1	A		

1.	2.	3.	4.	5.
13.	Survey workshop	Essential	A	
14.	Tentage Equipment for surveying camp	Essential for Survey Camp	A	
15.	Substense Bar (Inwar)	2	C	
16.	Glass circle. Theodolite Reading to 1" directly with all accessories	4	C or A.	
17.	Ewing Stadi Altimeter for use with a theodolite	1	Different types. C or A.	
18.	Direct Reading techometer with stand with all accessories	2	Different types C or A.	
19.	Station pointer	1	A	
20.	Parallax Mirror stereoscopes with parallel-lax bars, scales and other accessories	10	A	
21.	Binoculars Central focussing, Magnifying 10 times and twilight capacity 500	1	C	
22.	Range Finder	1	C	
23.	Chronometers.	1	C	
	Aneroid Barometers	4	C	
24.	Precise Level with Staff	1	C or A.	
25.	Automatic level	1	C	
26.	Geodetic level with stand and other accessories	1	C	
27.	Base line equipment	1 Set.	A	
28.	Sketch master	2	C or A	
29.	Radial line plotter with accessories	1 Set.	C	

GEOLOGY LABORATORY

Item No.	Item and Specification.	No. required	Category	Remarks
1.	2.	3.	4.	5.
1.	Student type Polarising Microscope	5	A	
2.	Brunton's Compass	1	A	
3.	Magnifying Lenses	20	A	
4.	Testing Sleeves with cover and pans	One Set	A	
5.	Horse-shoe Magnet	5	A	
6.	Contact Foniometer	20	C	
7.	Hardness Boxes	5	A	
8.	Steel Plate	1	A	
9.	Glass Plate	5	A	
10.	Brass Plate	1	A	
11.	Hammer	30	A	
12.	Westphal Balance	1	A	
13.	Jolly's Balance	1	A	
14.	Beam Balance	5	A	
15.	Complete Blow Pipe equipment set	1	A	
16.	Laboratory Reagents	-	A	
17.	A set of important Thin Sections of minerals (Properly oriented)	100	A	
18.	A set of important Rock-Sections	100	A	
19.	Important Metallic and Non-metallic Ores	One set	A	
20.	Important Sedimentary Igneous and metamorphic rocks	One set	A	



1.	2.	3.	4.	5.
21.	Lustre and colour collection of minerals	5 Sets	A	
22.	Cleavage collection	5 Sets	A	
23.	Fracture collection	5 Sets	A	
24.	Tenacity collection	5 Sets	A	
25.	Structure collection (Set of 50 minerals)	5 Sets	A	
26.	Collection of Building materials. (Set of 40 Rocks)	One Set	-	
27.	Rock cutting grinding and polishing machine	1	A	
28.	Clinometer compass	15	A	
29.	Map of India			
	I Geological Map	1	A	
	II Mineral Map	1	A	
	III Structural	1	A	
30.	Advance petrological microscope with oil immersion objective micrometers and accessories	1	A	
31.	Micrographic Camera	1	A	
32.	Photographic Camera	1	A	
33.	Diamond impregnated drill 1" dia. complete with accessories	1	A	

SOIL MECHANICS LABORATORY

Item No.	Item and Specification.	No. Required.	Category	Remarks.
1.	2.	3.	4.	5.
1.	Liquid Limit Device	2	A	
2.	Set of Sieves		A	(As per A.S. T.M. specification; where I.S.I. specification sieves are available 1 set of these also)
3.	Sieve Shaker (Hand operated)	1	A	
4.	Hydrometer	2	A	
5.	Stirrer. (Electric Mixer)	1	A	
6.	Constant temperature bath 25°C	1	A	
7.	Specific gravity bottles	2	A	
8.	Permeameter and accessories	2	A	(One constant head and one variable head)
9.	Consolidation apparatus	2	A	
10.	Consolidometer and accessories	2	A	
11.	Direct Shear apparatus	1	A	
12.	Direct shear box and accessories	1	A	
13.	Triaxial loading frame	1	A	
14.	Triaxial cell and accessories	2	A	
15.	Pore water Pressure measuring equipment	1	A	
16.	Air compressor (0 - 100 Psi)	1	A	
17.	Compaction hammer	2	A	
18.	Compaction mould	2	A	
19.	Harvard Miniature Mould & Tamper	1	A	

1.	2.	3.	4.
20.	Sand field density apparatus	1	A
21.	Oven (Thermostatic control to 150° C)	1	A
22.	Balances:		
	a. max. load 2 Kg.	1	A
	b. max. load 15 kg.	1	A
	c. max. load 200 Gm. - chemical balance	1	A
23.	Descicator	1	A
24.	Vacuum Pump	1	A
25.	Extruder (Multiple for various diameter samples)	1	A
26.	Glass ware - cylinder, beakers, tubes, burettes etc.	As necessary.	A
27.	Rubber ware - tubes, stoppers etc.	"	A
28.	Plastic ware - tubes, beakers, squeeze bottles	"	A
29.	Evaporation cans	"	A
30.	Evaporation Dishes	"	A
31.	Aspirator bottles	2	A
32.	Stop Clock	1	A
33.	Stop watches	1	A
34.	Dial gauges	2	C
35.	Magnetic clamps for dial gauges	2	C
36.	Thermometers:		
	a. 1 - 150° C	2	A
	b. 1 - 300° C	1	A
37.	Tools	As necessary.	A

1.	2.	3.	4.	5.
38.	First Aid Box	1	A	
39.	Shrinkage limit apparatus			
40.	Soil Trimmer	1	A	
41.	Unconfined compression Testing Machine (Spring type hand operated)	1	A	
42.	Sampling kit. consisting of Augers and drill rods, split spoon sampler and accessories	1	A	



सत्यमेव जयते

CONCRETE LABORATORY

Item No.	Item & Specification.	Number required	Category	Remarks
1.	2.	3.	4.	5.

For Test on Cement:

1.	Balance capacity 14 kg. accuracy 1 gm. including set of weights	2	A	
2.	Balance capacity 7 kg. accuracy 1 gm. including set of weight	2	A	
3.	Analytical Balance 200 gm. capacity accuracy 0.001 gm. with one set of weights	1	A	
4.	Vicat needle apparatus, complete for a setting time and consistency test as per I.S. 269	2	A	
5.	Gillmore needle apparatus as per ASTM C 191-44	1	A	
6.	Vibrating machine for mortar cubes as per I.S. 269	1	A	
7.	Standard cube moulds for item No.6 as per I.S. 269	6	A	
8.	Lechatelier flask for determining sp. gravity of cement ASTM C-188-44	2	A	
9.	Lechatelier moulds for soundness test as per I.S. 269	3	A	
10.	I.S. Sieve No. 9	3	A	
11.	Burrmeter Flow Through as per ASTM C 185-47T	1	A	
12.	Permeability apparatus with Manometer and Flowmeter as per I.S. 269	1	A	
13.	Autoclave capacity 2 cu. ft. and shrinkage moulds as per I.S. 269	1	A	
14.	Calorimeter for determining Heat of Hydration of Cement as per I.S. 269	1	A	

1.	2.	3.	4.	5.
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15.	Trowels, Hand Scoops and spatulas	4 No. of each	A
16.	Flow table as per ASTM C-91-58	1	A

For Tests on Aggregate:-

1.	I.S. test sieves as per I.S. 383	2 Sets.	A
2.	Platform type Balance capacity 100 Kg., 50 Kg.	1 No. of each	A
3.	Thermostatically controlled drying oven with variable temperature control, max. range 120°C capacity 3 cu.ft. with tolerance of $\pm 2^\circ$ C)	1	A
4.	Electric driven sieve shaker, capable of holding set of 7 sieves (including pan)	1	A
5.	Apparatus for aggregate impact test as per B.S. 812	1	A
6.	Apparatus for aggregate crushing test as per I.S. 383	1	A
7.	Sedimentation test apparatus as per B.S. 812	1	A
8.	Pycnometer	2	A
9.	Measures capacity 1 c.ft. or 0.01 metre	2	A
10.	Riffler box for Sampling	1	A, B.

For Tests on Concrete:-

1.	Cube moulds 10 cm. size as per I.S. 516	24	A
2.	Cube moulds 15 cm. size as per I.S. 516	12	A
3.	Cylinder moulds 15 cm. dia x 30 cm. height as per I.S. 516	6	A

1.	2.	3.	4.	5.
4.	Slump cones as per I.S. 1199	2	A	
5.	Compacting factor apparatus as per I.S. 1199	1	A	
6.	Vee-Bee Consistometer as per I.S. 1199	1	A	
7.	Flow table 30" top dia. (76.2 cm. dia) as per I.S. 1199	1	A	
8.	a. Moulds for beams (flexural test) 15 cm. x 15 cm. x 70 cm., 10 cm. x 10 cm. x 50cm. as per I.S. 516	3 No. of each.	A	
	b. Bearing Plate for the above as per I.S. 516	1 No. of each	A	
9.	Concrete mixer, Power driven, capacity 3 cu.ft. dry materials	1	A	
10.	Compression Testing machine 200 tonne capacity, electrically operated with at least 3 ranges 0 to 50 tonnes, 0 to 100 tonnes, 0 to 200 tonnes. Clear head room 2' 6" at least	1	A	
11.	Air Conditioner 1½ tonne capacity with temp. and humidity regulator with humid chamber	2	A	
12.	Dial gauge sensitivity 0.001" with magnetic bases	6	C	
13.	Stop watches accuracy 1/5 seconds	2	C	
14.	Gifford Udall Prestressing Equipment (Prestressing jack, Pump, prestressing bed and all the accessories like anchorages, anchor plates etc. complete)	1 set.	A	
15.	Length comparator for determining drying shrinkage and moisture movement as per I.S. 1199	1	A	

1.	2.	3.	4.
16. Rack type curing tank with water circulating pump, thermostatic control etc. for a minimum of 200 cubes		1	A
17. Beam testing frame (1 metre span)		1	B
18. Reaction type loading frame 100 tonne capacity column upto 8-10' high (3 metre high)		1	B
19. Load capsules or Dynamometers capable of measuring reactions upto 20 tonnes		2	A
20. Remote Control hydraulic jacks, with pressure gauge flexible tubing etc. capacity 50 tonnes and 100 tonnes. (Travel 12 cm.) each with flexible tubing 5 m. long		1 No. of each.	A
21. Proving rings capacity 5000 Kg. and 10,000 Kg.		1 No. of each.	A
22. Compressometer suitable for 6" dia. (15 cm.) 12" high (30 cm.) cylinder		2	A
23. Cylinder Copper (for capping cylinders)		1	A
24. Sonic Concrete Tester as per I.S. 516		1	C
25. Ultrasonic Concrete Tester;			
a. Pulse frequency upto 200 Kc.		1 Set	C
b. Cathode ray oscilloscope indicator for measuring time of pulse travel (Reading upto 1 micro second)			
26. Needle vibrator operated by $\frac{1}{2}$ h.p. motor, needle not less than 1" dia. and 18" length		1	A
27. Table vibrator suitable to handle load upto 300 lb. or 4 cube moulds at a time. Top - 24" x 24" minimum and intensity of vibration 4200/minutes.		1	A

1.	2.	3.	4.	5.
28.	Bond Test Apparatus as per ASTM C-234	1	B	
29.	Demec Demountable strain gauges	2	C	
30.	Shutter or Form Vibrator	2	A	



सत्यमेव जयते

STRUCTURES LABORATORY

Item No.	Item and Specification.	Number required	Category	Remarks.
1.	2.	3.	4.	5.
1.	Experimental models of various Structures similar to Pippard & Banker Models	A Set of 20 No.	A, B,	
2.	a. Dial gauge with magnetic base, accuracy 0.0001" travel $\frac{1}{2}$ "	12	C	
	b. Dial gauge with magnetic base, accuracy 0.0001" travel 1"	12	C	
3.	Cathetometer (Travelling microscope)	2	A	
4.	a. Reaction type loading frame capable of testing beams, capacity 20 tonnes. It should have longitudinal main girders and cross girders whose spacing can be adjusted according to requirements	1	B	
	b. Reaction type loading frame capable of testing slabs capacity 20 tonnes. It should have longitudinal main girders and cross girders whose spacing can be adjusted according to requirements.	1	B	
5.	a. Remote control hydraulic jack 0-5 tonnes, 0-10 tonnes and 0-20 tonnes with flexible tubing 5 m. long travel 20 cm.	1	A	
	b. Proving Rings 5 ton capacity	2	A	
	10 ton capacity	2	A	
	20 ton capacity	1	A	

1.	2.	3.	4.	5.
6.	Load capsules and Dynamometers capable of measuring reactions upto 20 tonnes	2	A	
7.	Slotted Weights 100 gm. to 2 Kg.	10 Sets.	A	
8.	Desk Calculators	3	A	
9.	Photo Elastic bench complete with accessories:			
a.	Photo elastic equipment comprising of 12" diffused light Polariscopes, loading frame, and camera	1 Set.	C	
b.	Accessories to the above equipment - elastic annealing oven plastic polishing machine etc.			
10.	Hey's Deformeter with its accessories alongwith Plastic models of various structures which can be used for model analysis	1 Set.	A	
11.	Strain gauges with transducers with direct strain measuring units etc. complete	1 Set	A	
12.	Hand operated Universal Testing Machine 5 Ton capacity	1	A	
13.	Demonstration Models of Different kinds of structures	Set of 12.	B	
14.	Hydraulic Rams 6 No. with manifold connections connected to an electrically operated pump of 10 ton	1 Set.	A	
15.	Huggen-bergner gauges	6	C	

1.	2.	3.	4.	5.
16.	Lateral Extensometer (Hildshev)	1	C	
17.	Dial Indicator type Extensometer	2	A	
18.	Single mirror extensometer	1	C	
19.	Electronic equipment for dynamic testing (as required).	1 Set	A	



सत्यमेव जयते

STRUCTURAL ENGINEERING WORKSHOP

Item No.	Item and Specification.	Number required	Category	Remarks
1.	Lathe Machine 3-1/2 ft length 5" centre with electric motor and accessories:			
	Tools: 1. Self Centring Chuck 5-1/2"	1	A	
	2. Independent Four jaw chuck 6"	1	A	
	3. Drill Chuck with key 1/2" capacity	1	A	
	4. Face Plate 10"	1	A	
	5. Centres 60"	2	A	
	6. Centre Plates 5"	1	A	
	7. Cutting tool: "V" shape, part off, Thread cutting, Boring inside, Inside Thread cutting, Right hand, Left hand. This machine is useful for turning, facing, boring, Thread cutting of metals and plastic metal.	8	A	
2.	Jigsaw machine 24" neck with electric motor.			
	Tools: Jigsaw blade.	1 Set	A	
	This machine is useful for cutting curves in wood and plastic.			
3.	Tool grinding machine 8" dia. Emery wheels with electric motor.			
	This machine is useful for shaping the tools and drill point.	1 Set.	A	

1	2.	3.	4.	5.
4.	Power saw machine 9" capacity with electric motor. Tools: 14" H.S.S. cutting blades This machine is useful for cutting the bars, channels, I-section etc.	1 Set.	A	
5.	Fly Press: This machine is useful for blanking the sheet work, bending the bars, cutting small bars and pressing the sheet work. Tools: Dies for the above work as required.	1 Set.	A	
6.	a. Arc Welding Set with leads and holder. This machine is useful for welding in M. Steel. b. Gas welding set complete	1 Set.	A	
7.	Radastal Drill Machine 1" capacity This machine is useful for drilling the holes in metals, wood and plastic. Tools: Drill set 1/8" to 1" rising by 1/32".	1 Set.	A	
8.	Shaping machine	1 Set.	A	
9.	Carpenter's Tools	1 Set.	A	
10.	Fitting Tools	1 Set.	A	

EQUIPMENT REQUIRED FOR PUBLIC HEALTH ENGINEERING
LABORATORY

Item No.	Item and Specification.	Number required.	Category	Remarks
1.	2.	3.	4.	5.
1.	<u>Analytical Balance</u> : To weigh upto 200 mg. sensitivity 0.1 mg. in its own double door case	2	A	
2.	<u>Weights for Analytical Balances</u> : In box with forceps and rider complete chromium-plated or nickelled. To weigh upto 200 gms.	2 Sets.	A	
3.	<u>Rough Balance-Double Pan type</u> : To weigh upto 2 Kg.	1	A	
4.	<u>Weights for Rough Balance</u> : Nickelled weights 10 Kg. to 2 Kg. in case	1 Set	A	
5.	<u>Thermostatic Water Baths</u> : To have a working space of about 15" x 15" x 8" deep with thermostatic control to 0.5°C accuracy - with a steam-dome. In let and outlet arrangements complete. To be worked on 220V/440V A.C.	1	A	
6.	<u>Still</u> : 8 pks/hour. To be electrically operated Automatic - 230V, Ac1/3 phase 50 c.p.s.	1	A	
7.	<u>Microscopes</u> : (With illuminating system, students type with accessories, with slide cabinet of 50 standard slides)	2	A	
8.	<u>Stop watches</u> : Backelite Body; Start, Stop and flyback Action - 5 minutes x 1 second	2	A	
9.	<u>Inhoff cones</u> (10)	2	B	

1.	2.	3.	4.
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10. Drying oven with thermostat/Hot air oven with thermostat. Made of stainless still or copper-double walled with glass wool or other insulation material packing between the wall layers - with one shelf - and provided with two shelf positions - on iron stand with (Bimetallic) thermostatic control from 250 C to 2500 C within an accuracy of $\pm 0.50^\circ \text{C}$ - (18" x 18" x 18") or 14" x 14" x 14" working space. Inside with asbestos lining-Painted silvergrey hammered tone synthetic enamel. Heating elements are to be distributed at the bottom and on the side for obtaining a uniform temperature in the entire cabinet. To be worked on 230V.Ac.1/3 temperature with selector gauge, perforated trays, signal lamps, plug, wire, keys and locking. Specify wattage rating. 1 A
11. Refrigerator - 6 Cft: Fine finish with precision control - working space 2' x 1 $\frac{1}{2}$ ' x 2 $\frac{1}{2}$ ' deep 1 A
12. PH Meters: Mains operated 220V, 1 phase 50 cps (with voltage compensator). For complete range) to 14 PH. Accuracy plus/minus 0.05 PH. Direct reading, temperature compensated model. Zerodrift compensation. High discrimination. Wattage not more than 60W. To quote with complete set each of glass, metal and reference electrodes with electrode stand Electrodes to have resistance upto 500 megohms, millivolt scale upto 800/1000mV, with resistance thermometer and millivolt adaptor, mV and mA recorders, buffer tablets and buffer solution. Compactly contained. 2 complete sets of electrodes. 2 sets of beakers, water bottles etc. 1 Set B

1.	2.	3.	4.	5.
13.	<u>Turbidimeters: (Jackson candle type):</u> According to design of Metropolitan Water Board Laboratories - for determination of turbidity in water supplies and other fluids. Spare sockets and lamps. 220W, 1 phase 50 cps.; Sensitivity 0.1 ppm.- Liquid column to be about 15 cm/45, with accessory galvanometer, set of screens and surface glasses.	1 Set.	B	
14.	<u>Chloroscopes:</u> Field testing portable unit with a full set of bowls/tubes, accessories and chemicals. To determine both marginal and breakpoint chlorination.	1 Set.	A	
15.	<u>Multiple stirring apparatus:</u> To contain 6 vertical stirrers upto 20 cms. depth, spaced about 10 cms. apart with drive with speed reduction attachment, with cross rod, connector sleeves, and driving belt. Drive from 220V, 1 phase 50 cps.	1 Set.	A & B1	
	Flocculator-Jartest Apparatus	1	B	
16.	<u>Tools Chest:</u> Containing handsaw, glass cutter, glass cutting and polishing files, pair of scissors for cutting and fitting rubber etc. postings hammer haneled chisel twinscrews, 2 gimlets, pliers, plane oil stone, glass grinder, 2 files, pincers, rasp, bench vice, rule square, dividers, universal wrench, screws, nails, electric soldering iron with adaptor and cord.	1	A	
17.	<u>Retort stands and clamps:</u>			
	a. Rebert stands of cast iron base, black painted superior, with iron rod, Turned and polished.	20	A	
	b. Universal clamps - brass or copper coated iron oxidised or galvanised on the exterior, heavy pattern -	10		
	-do- medium pattern	10		
	Condenser clamps	6		

1.	2.	3.	4.	5.
18.	Retort rings - with fixed boss and totally copper oxidised or galvanised	20	A	
19.	Tripped stands and accessories			
	Triangular of Iron 5 nos.			
	Circular of Iron 5 nos.			
	Triangular of Iron 5 nos.	30	A	
	Circular 8" high of Iron with hot air cone made of G.I. 8" high 10 nos.			
20.	Crucibles, Porcelain Assorted Sizes - with lids: 15 c.c., 28 c.c., 50 c.c., - each 5 nos.			
	Tongs for crucibles made of brass wire, nickel plated - 10" long - 15 nos.	20	A	
21.	Bunsen Burners, of G.I. with Black painted base and nickel plated pipe, with devices for regulating gas as well as air, superior quality - 5 nos.			
	-do- large pattern for strong flame - 3 nos.	13	A	
	Blow pipe burners for blowing purposes - of superior quality - 2 nos.			
22.	Corkscrews of different sizes, made of steel with separate handles. 1/8" m., 3/16", 1/4", 5/16", 3/8", 1/2" - 2 to 3 each.	20	A	
23.	Aspirator Bottles, with ground - in stopper and stopcock	12	A	
	3 nos. - 2 litre capacity - pyrex glass			
	3 nos. - 3 litre capacity - "			
	6 nos. - 5 litre capacity - "			

1.	2.	3.	4.	5.
24.	<u>Bacteriological Incubator:</u> 14" x 14" 14" size Incubator cabinet is to be double walled with two doors - made of mild steel except for the inner door which is to be of well seasoned wood - with a glass panel for observation. 230V. A.C. (Temp. 50° +0.50°C) - with pilot lamp. Complete with suitable length of 3 core. wire with socket and pin plug - with 2 shelves at adjustable positions - working space 14" x 14" x 14".			
		1		A
25.	<u>Comparators:</u> for all pH determination, complete with two glass through 13 mm. depth - 1 milk glass plate, two test tubes, graduated, 5 to 10 c.c. with stand with pipettes and discs) - 2 nos. <u>Colour discs</u> Merk's Universal, Indicator-Bellige - 3 Nos. Bromo cresol green - or cresol red - 3 Bromothymol blue - or phenol red - 3 Methyl Red - Bromophenol red - 3 Methylol Blue - phenolphthalein - 3			
		2		A & B
26.	Indicator pH solutions of all ranges BDH 1000 c.c.			
27.	Horizontal Autoclave with external steam generator			
		1		A
28.	Hot Plate			
				A
29.	<u>Miscellaneous glass ware and accessories:</u>			
	i. Beakers: Low form: with spout ii. Beakers: Tall form: with spout iii. Beakers Holders: made of brass - 20 nos. iv. Bottles with stoppers: B.O.D. Bottles v. Reagent Bottles with dust proof stopper with narrow mouth			
				A

1.	2.	3.	4.
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- vi. Woulf's bottles
- vii. Weighing Bottles: wi
- viii. Burettes, with straight glass stopcock
- ix. Microburettes with stopcock and funnel top
- x. Leibig condensers
- xi. Measuring cylinders
- xii. 4" culture dishes
- xiii. Carboys for storing distilled water
- xiv. Evaporating dishes
- xv. Boiling flasks
- xvi. Conical flasks
- xvii. Filtering funnels
- xviii. Volumetric flasks
- xix. Separating globular or pear shaped funnels
- xx. Volumetric pipettes
- xxi. Stainless steel stirrers with two fixed vanes
- xxii. Test tubes with rims
- xxiii. Watch glasses with fine polished edges
- xxiv. Funnel stands
- xxv. Pipette stands
- xxvi. Wire gauges
- xxvii. Clay pipe triangles
- xxviii. Test tube racks
- xxix. Tongs
- xxx. Desiccators



1.	2.	3.	4.	5.
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xxxi.	Tongs			
xxxii.	Desicators			
xxxiii.	Glass wash bottles			
xxxiv.	Polythene wash bottles			
xxxv.	Drop bottles with glass toppee			
xxxvi.	Drop bottles with ink filed type			
30.	Museum sanitary fittings, like, venturameter auto flow recorder, various types of bib cocks, different types of valves, water meter, flush, cistern and joints etc. Acquaphones with section			A & B
31	Working models of water treatment plant (comprehensive) trickling filter, Activiated sludge process (Air diffusion tank) Septic tank			A & B
32.	Standard sieves and sieve shaker as per I.S.I.	1 Set	A	
33.	Stoces law verification apparatus	1	A	
34.	Electrical conductivity apparatus	1	A	
35.	Field kit similar to one supplied by W.H.O. for testing water. in the field (Hand of kit for class demonstration)	1 Kit.	C & B	

HIGHWAY LABORATORY

Item No.	Item and Specification.	No. required.	Category	Remarks
1.	2.	3.	4.	5.
1.	<u>Red wood No. 1: Viscometer (Electrically heated type)</u> : complete with: a. Silver plated ball valve b. Spirit level c. Cup cover d. Chromium plated thermometer clip e. Flask capacity 50 mls. f. Oil cup and jet with N D certificate This equipment should be capable of operation from 230 volts 50 cycles AC supply	1	A	
2.	<u>Red wood No.2 : Viscometer (Electrically heated type)</u> . It should meet the requirements of I.P. 70 and I.S. 454 : 1953 complete with: a. Silver plated ball valve b. Cup cover c. Chromium plated thermometer clip d. Flask capacity 50 mls. e. Oil cup and jet with N.P.L. certificate This equipment should be capable of operation from 230 V. 50 cycle AC supply	1	A	
3.	<u>Abel Flash point apparatus with thermometer</u> for determining the closed cup flash points of petroleum products and mixtures complete with: spare oil cup with cover	1	A	

1.	2.	3.	4.
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4. Pensky Martens (closed) Flash Point apparatus: I.S. 1209 : 1958 for determining the flash point of petroleum products having a flash point above 120°F. complete with: 1 A
- a. Oil cup fitted with heat resistant handle
 - b. Lid, shutter stirrer with gas test jet
 - c. Clip which fits on the rim of cup (closed).
5. Standard Penetrometer meeting requirements of I.S. 310 (part II) 1954 for testing penetration of bitumen, tar etc. Its dial should be graduated from 0-400 in one-tenth millimeter sub-divisions. Complete with plunger and weights of 100 and 50 gms. It should be accompanied by a water bath capable of maintaining temperature of $25^{\circ} \pm 0.5^{\circ} \text{C}$ 1 A
6. Stop watch accuracy 1/5 sec. with bench stop watch holder 3 A
7. Ring and Ball apparatus provided with electric heater unit complete with: 1 A
- a. Ring with centering guide and ball
 - b. Ring holder
 - c. Two steel balls 3/8" dia. each
 - 1. One breaker

1.	2.	3.	4.	5.
8.	<u>Standard Tar Viscometer (gas heating)</u> meeting requirements of I.S. 1206 : 1958 for determining the viscosity of cut back bitumen and road oils. Complete with:	1	A	
	a. Tar cup with 10 mm. orifice			
	b. Ball valve for 10 mm. orifice cup			
	c. Tar cup with 4 mm. orifice			
	Ball valve for 4 mm. orifice cup			
	<u>ler's Viscometer: (gas heating)</u> for determining viscosity of lubricating and l oils. As per A.S.T.M. D 490	1	A	
	<u>all Stability Test Apparatus with</u> necessary accessories and providing ing. It should be accompanied by a water bath having large variation of temp. viz - 40° to 120°C (tentative) should meet requirements of A.S.T.M. Designation D 1559.	1	A	
11.	<u>Ductility Testing Machine (I.S. 1208:</u> 1958) with ductility moulds	1	A	
	<u>Habbarid-Field Test Apparatus complete</u> with all accessories and a motor (Conform to A.S.T.M. Designation D-1138)	1	A	
	<u>Oven of size 18" x 18" x 24" upto 200°C</u>	1	A	
	<u>stillation apparatus I.S. 1208, 1958</u>	1	A	
	<u>Pump capacity (2 atmospheric</u> e)	1	A	
	<u>crushing Test Mould</u>	1	A	
	<u>abrasion Machine with 12</u> of 17Q and weighing nd one tray	1	A	

1.	2.	3.	4.	5.
18.	Deval's attrition machine for determination of resistance to wear by attrition with motor	1	A	
19.	Dorry's abrasion machine for testing resistance to wear by abrasion of rock pieces	1	A	
20.	Aggregate Impact testing machine with a standard mould and Tamping rod	1	A	
21.	Sample Extrusometer for samples of dia. 6", 4" and 1"	1	A	
22.	Thermometers upto 300° C and 100° C	6	A	
23.	Electric hot plates - 1000 or 2000 watts	2	A	
24.	Standard Sieve set (A.S.T.M. and B.S. & I.S.)	3	A	
25.	Large Sample splitter	1	A	
26.	Small Sample splitter	1	A	
27.	Thickness Gauge	1	A	
28.	Length Gauge	1	A	
29.	Vacuum desiccator 8" internal diameter	2	A	
30.	Loading frame 20T capacity with a variety of speeds	1	A	
31.	Balance 20 Kg. Capacity with removable pans including set of weights	1	A	
32.	10 WA Bearing valve Apparatus	1	A	
33.	C.B.R. Testing machine and moulds (6 nos.)	1	A	

1.	2.	3.	4.	5.
34.	North Dakota cone test apparatus	1	A	
35.	Loss on heat testing (of bitumen) apparatus	1	A	
36.	Miscellaneous equipment like beakers, funnels, containers etc.	Lump Sum		
37.	Sp. gravity bottles for testing sp. gravity of bitumen	12	A	
38.	Analytical balance with accuracy 0.001 gm. with one set of weights	1	A	



सत्यमेव जयते

HYDRAULICS LABORATORY

Item No.	Item and Specification.	No. required	Cate-gory	Remarks
1.	2.	3.	4.	5.
1.	Pumping set for supply of water to the laboratory, One for 600 gpm. and another for 1100 gallons/min., 60 ft. head	2	A	
2.	Water supply reservoir (underground) 15,000 Gallons approx.	1	B	
3.	(a) Constant head (overhead) tank with a skimming weight to maintain constant head within 2%. Tank capacity 800 gallons	1	B	
	(b) Pipes and Pipe fittings for connecting the overhead and underground reservoirs and connecting the overhead tank to individual experiments	Lumpsum (as per experiments of particular laboratory)	A	
3.	Manometers of different types. Pressure and Vacuum gauges of different ranges should be provided	Lumpsum	A B C (Precision type only)	
4.	Apparatus for studying impact of jets on vanes of different types	1	A B	
5.	Apparatus for studying curvilinear flow in conduits with a provision to vary the pressure difference at inlet and outlet for cavitation studies, and for studying Bernoulli's Theorem	1	B	
6.	Apparatus for studying flow through orifices, Nozzles, Venturimeters, Notches consisting of:	1	B	
	i. Constant head tank			
	ii. Steadying tank			
	iii. Measuring tanks			

1.	2.	3.	4.	5.
7.	Different types and sizes of Orifices, nozzles for item 6.	Lumpsum	B-1	
8.	Different types and sizes of notches from item 6.	Lumpsum	B-1	
9.	One volumetric calibration tank of 2500 gallons (underground capacity with provisions to connect equipment through a three way diverter and pumping set for emptying tank	1	B-1	
10.	Orifice plates and venturi meters of different sizes for main supply pipes for individual experiments	Lumpsum	A B-1	
11.	A unit for determining head losses in pipe fittings such as bends, valves, sudden expansion, contractions, nozzles, orifice and venturi meters, branching pipes etc-.	1	B-1	
12.	Oil and Air Pipe for studying flow development in laminar and turbulent flow through pipes including one gear pump and a centrifugal blower with speed control etc.	1 of each	B-1	
13.	Centrifugal pump with variable speed motor or variable speed V. belt drive, 250 Gpm at 60' head with necessary energy meters, tachometer etc.	1	A	
14.	Francis Turbine with rope, brake dynamometer to work on 50' head, 5 H.P. at 1250 r.p.m. with suitable pump-motor set etc.	1	A	
15.	Pelton wheel with rope brake dynamometer 5 H.P. at 200' head with suitable pump-motor set etc.	1	A	
	Multistage centrifugal pump to supply 50 gallons at 250 head with variable speed drive to supply water to flumes or for other experiments.	1	A	

1.	2.	3.	4.	5.
17.	Hook and Point Gauges (some with electrical contact devices)	Lumpsum	A, B-1	
18.	Pilot - static tubes, and static pressure probes	Lumpsum	A, B-1	
19.	Water meters of two different types for visualisation	2	A or C	
20.	Assorted instruments such as stop watches, meter scales, thermometers	Lumpsum	A	
21.	Equipment such as pumps, valves etc. for dismantling, refitting exercises	Lumpsum	A	
22.	Hand tools and pipe fittings tools, such as pipe cutters, dies, pipe vice etc.	Lumpsum	A	
23.	Kaplan Turbine 5 H.P. at 15' head with rope brake and oil pressure Governor with suitable pump-motor set etc.	1	A	
24.	Axial flow pump with variable speed drive, 2 cfs at 20' head	1	A	
25.	(a) 6" wide, 18" deep x 10 ft. long closed circuit tilting flume can be supplied with water from overhead tank or experimental pump sets	1 1	A, B-1	
	(b) 12" wide, 18" deep and 60' long tilting flume water to be supplied by overhead tank or by experimental pump sets	1	A, B-1	
26.	Apparatus for measurement of water hammer surge in pipe line and transducers to measure dynamic pressure with necessary recorder	1	B ₁ , C	

1	2	3	4	5
27.	Assorted runners of pumps and Turbines	Lumpsum	A	
28.	Current meters for measurement of velocity (including micro current meters and digital readout):			
1.	Cuptype	2	A or C	
2.	Propeller type	2	A or C	
29.	Models of Hydraulic Structures to be used with Item 32.	As required	B ₁ , A	
30.	Hydraulic Model tray 8' x 8' x 12" along with 2 pumps-motor sets	1	B ₁ A	
31.	Closed circuit tray 24" wide 5 ft. long and 4" deep with 1/2hp pump motor set for flow visualization including Head and tail tank, tilting sluice gate, false glasssheet and necessary models	1	A, B-1	
32.	Electrical Analogy Apparatus along with a 10 volts A/C supply at 10,000 cycles, a Null detector and a wheat stone bridge	1	A, B-1	
33.	One 100 Kg. weighing machine (Platform scale) (dial type)	1	A	
34.	Hand tachometers 0 - 10,000 r.p.m. and revolution counters (reset type and with reverse and forward motion)	2 each	A	
35.	Subsonic wind tunnel 12" x 12" x 5' long alongwith a fan to obtain a velocity of 100 ft./sec. and damper speed control arrangement. (Models can be made as necessary by the Laboratory personnel)	1	A, B-1	

1.	2.	3.	4.	5.
36.	Pipe Friction apparatus	1	B-1	
37.	Reynolds apparatus for demonstration of stream-line and turbulent flow	1	B-1	
38.	Reciprocating pump with variable speed drive, indicator gear and air vessels etc.	1	A	
39.	Hydraulic Ram	1	A	
40.	Apparatus for determination of metacentric height	1	A, B-1	
41.	Equipment to study superposition of elementary potential flow patterns	1	B-1	
42.	Gear pump with variable speed arrangement	1	A	
43.	Fluid coupling, torque converters for demonstration	1 each	A	
44.	Spare pumps, blowers, fans etc. for building apparatus projects.	As required	A	



LIST OF EQUIPMENT FOR LABORATORIES IN INSTITUTIONS
FOR CONDUCTING CHEMICAL ENGINEERING DEGREE COURSES.

SYMBOLS

- A = Items indigenously available
B = Items to be assembled by colleges
C = Items to be imported

(NOTE: As far as possible equipments should be constructed in stainless steel or non ferrous metals)

Momentum Transfer

S.No. (1)	Item and specification (2)	Category (3)
1.	Orifices of different diameters and types in pipe lines, venturi, nozzle with centrifugal pumps manometers and tanks. ($1\frac{1}{2}$ " and 2" pipe lines)	A
2.	Centrifugal pumps with variable speed and different types of impellers (or three centrifugal pumps with different characteristics) with pressure gauges, flow meters, energy meters and tanks.	A, B
3.	Pipe lengths of different diameters and different types of pipe fittings with centrifugal pump, manometers and tanks.	A, B
4.	A set of helical coils with varying diameter of coils and number of turns per unit height (3 different diameter of tubes) with centrifugal pumps manometer, flow meters and tanks.	A
5.	Two packed columns with transparent top section arranged for quick changing of packings with centrifugal pump, blower, packings, flow meters, manometers and tanks - one for pneumatic and one for hydraulic flow	A
6.	Complete experimental fluidizing column a) with compressor, air dryer, flow meter and manometers for pneumatic and b) with pump, flow meter and manometers for hydraulic systems.	A, B

(1)	(2)	(3)
7.	Compressor and vacuum pump with flow meters, manometers for efficiency studies.	A
8.	Line with orifice meter, pitot tube and venturi with compressor/blower, flow meter, manometer.	A, B
9.	General equipment for gas flow measurement by pitot tubes in rectangular and round ducts with blowers and travelling pitot tubes.	A, C
10.	Flow tank with interchangeable notches and weirs and water pumps.	A
11.	Slurry pump with tank and pipe lines.	A
12.	Air lift with compressor and flow meters.	A
13.	Demonstration apparatus for Laminar and Turbulent flow.	A, B

Heat Transfer

14.	Four concentric pipe heat exchangers with steam traps, c' fugal pumps, thermometers, flow meters, thermocouples and potentiometer, pressure gauges, tanks, traps, and steam generator for L-L, G-G, V-L, V-G. heat transfer systems.	A
15.	Heating cum cooling coil ($\frac{1}{2}$ " pipe-30' long) in tank with variable speed stirrer, c' fugal pumps, heating tanks, coolers, traps, thermometers, flow meters, steam-generator.	A
16.	Coil enclosed in a tank and tubular condenser (5 sq.ft.area) for condensing vapours complete with vapour generator and auxilliary condensers, c' fugal pumps, steam traps, thermometers, flow meters.	A
17.	Tubular condenser with baffles on the vapour side and suitable for converting into 2-, 4- and 6 passes on tube side with c' fugal pumps, steam-generator, steam traps, pressure gauges, flow meters and thermometers (5 sq.ft. $\frac{3}{4}$ " tubes 4' long).	A
18.	Solar heater complete with heater, tanks, flow meters, thermometers (20 sq.ft.)	A

(1)	(2)	(3)
19.	Jacketted heating unit 18" dia. with stirrer of variable speed, steam generator, steam traps, pressure gauges, thermometers (50 litres capacity).	A
20.	Plate type heat exchanger with steam generator o' fugal pump, steam trap, flow meters, pressure gauge, thermometers.	A
21.	Plain bank of finned tube air heaters with three different types of fins with steam generator, steam traps, blowers, flow meters, thermometer and pressure gauges.	A
22.	Electrical muffle furnace 8" x 12" x 18" to work at 1600°F with thermocouple, at the junctions of four insulating layers and heating coils with o' fugal pumps for liquids, blower for air, thermometers and flow meters.	A, C
23.	A set of 4 pipes (a) with different emissivities and b) with varying thicknesses of insulation with steam generator, traps, pressure gauges and thermocouples (4" to 6" dia. pipes, 36" to 24" long).	A, B
24.	Oil or coal fired or electrical boiler complete with accessories - preferable package type 1000 lb./hr. at 100 psig.	A

Heat and Mass Transfer (Vaporisation Processes)

25.	A 'tray dryer' with blower, air conditioner, weighing arrangements with chainomatic balance, stop watch, temperature and humidity recorders 30 sq. inches to 40 sq. inches tray area.	A, C
26.	Experimental rotary dryer with variable inclination, flights and R.P.M. complete with all accessories and instruments (6" dia- 4' long).	A
27.	Stills for Vapour-Liquid Equilibrium Studies complete with all accessories and instruments. Six different types - two to be suitable for higher pressures.	A, C

(1)	(2)	(3)
28.	Experimental distillation column with complete provision for measuring feed rate, reflux, top and bottom product rate, heat input, and cooling water rate with sets of five B.C. sieve, turbogrid plates and packed column with facility for quick change of packings arranged for putting into operation any one of the sets (B.C. plates 6" dia, sieve plates 3", Turbo-grid plates 4" dia. and packed section 4" dia. x 18" high) complete with controllers and recorders for study of instrumentation also glass or perspex sections preferably.	A, C
29.	A set of: a) standard vertical effect evaporator (3 to 5 sq.ft. H.S.) (b) long tube evaporator (3 to 5 sq.ft. H.S.) and (c) forced circulation evaporator (3 to 4 sq.ft. H.S.) to work as individual units or combined to work as multiple unit under vacuum with arrangements for forward, backward, mixed and cross feed and with vapour bleeding with vacuum pumps, circulating pumps, condensers, entrainment separators, steam traps, flow meters, thermometers, pressure and vacuum gauges and steam generator; (a) and (b) to have arrangement to vary liquid level.	A
30.	Standard vertical effect evaporator (8 to 10 sq. ft. H.S.) using thermo-compression complete with all accessories and instruments and steam generator.	A, C
31.	Unit for evaporation by radiant energy absorbed by the surface of liquid under varying air conditions (temperature, velocity and humidity) with air conditioner and circulator, source of radiant energy, velometer, psychrometer, photo-electric meters, thermometers (1.5 to 2 sq.ft. evaporating area).	B, C
32.	Climbing film evaporator single tube ($1\frac{1}{4}$ " dia x 10' height exposed to steam) complete with condenser, entrainment separator, receivers, thermometers, flow meters, and steam generator with arrangement for varying height of liquid in tube.	A

Mass Transfer Operations (Diffusional)

33.	Experimental wetted wall glass column for absorption studies (3" dia. and 6' high). Complete with all accessories and measuring instruments.	A, B
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(1)	(2)	(3)
34.	Experimental packed glass column with facilities for quick removal of packings for absorption studies (3" dia. and 4' height of packings). Complete with all accessories and measuring instruments.	A, B
35.	Experimental spray chamber unit for air water interaction studies with different types of spray nozzles (one spray only). Complete with all accessories and measuring instruments.	A, B
36.	Flask shaker and thermostat for six flask for coefficient studies.	A
37.	Experimental packed glass columns (2" dia. x 10' packed height) with four typical types of packings for liquid-liquid extraction studies (complete with all accessories and measuring instruments to use one column at a time).	A, B
38.	Experimental Schiebel column (2" dia. x 10 stages, 6" packing height for each stage) or "Rotating disc. column for liquid-liquid extraction studies. Complete with all accessories and measuring instruments.	C
39.	Jacketted batch cum/continuous crystallizer with helical cooling coil stirrer (9" width and 10' long).	A
40.	Experimental packed cooling tower with blower and water circulating pumps complete with all accessories and measuring instruments (12" x 12" by 7' to 8' height).	A

Mechanical Operations

41.	Jacketted and plain mixing tanks (8" x 10") with different types of propellers adjustable baffles, inlet and outlet for flow of liquids (two tanks each type).	A
42.	Experimental plate and frame press with one plate and 2 frames (9" x 9"), full cake washing type complete with accessories and pump to transport slurry.	A
43.	Experimental single leaf vacuum filtration unit with slurry tank stirrer, vacuum pump, filtrate receivers (20 sq. inches filtering area on each side).	A

(1)	(2)	(3)
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Instruments and Recorders (for instrumentation laboratory)

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|-----|--|------|
| 63. | Bellow type pressure indicator for gases and liquids, max. pressure 2.5 kg. per sq. cm. (3 Nos.) | C |
| 64. | Bourdon tube pressure recorder (spring driven) for gases and liquids up to a max. pressure of 15 kg per sq. cm. (with circular charts (2 Nos.)) | C |
| 65. | Pen recorder for registering control variables like pressure or temperature to be used with pneumatic balance, pressure range 0.2 - 1.0 kg. per sq. cm. with 100 mm. scale, chart speeds 20 mm/hr, 40 mm/hr. | A, C |
| 66. | Transducers for process variables (24 Nos.) | C |
| 67. | Bell type indicating flow meter range 100 kg. per hour. | A, C |
| 68. | Differential float indicating monometer with an electrical 3 position contact device, scale 0-100 kgs. per hour pressure drop 0-63 mm of Hg. | A, C |
| 69. | Flow recorders (Ring balance type) with manual and automatic selector switch. | C |
| 70. | Differential pressure recorder, measuring range 500 mm. water gauge 30 cm. chart, 220 V. 50 cycles per second synchronous motor drive, 8 h, 24h, 48h, 7 days chart rotation. | C |
| 71. | Position displacement water meters for continuous measurement of flow. | A |
| 72. | Rotary piston volumetric meter with setting register and shut off valve. | C |
| 73. | Rotating disc total flow indicating meter. | A |
| 74. | Manually adjusted, indicating potentiometer with built in standard cell circuit for use with thermocouples (2 Nos.) | A |

(1)	(2)	(3)
75.	Millivoltmeter pyrometer to be used with thermocouple junction, dial calibrated for direct reading of temperature range 0-600 C. (The calibration is with reference to cold junction at room temperature in tropical countries) (2 Nos.)	A
76.	Precision measuring Thompson Bridge to be used with a platinum resistance thermometer.	A
77.	Radiation pyrometer, Max. Temp. 1500 C with electrical output.	C
78.	Optical pyrometer filament type for measurement of temperature upto 1500 C by manual adjustment.	C
79.	Potentiometric recorder single channel, sensitivity full range - 1 to 0 to + 10 mv, 28 cms. scale, chart speeds 5 mm/min. and two other speeds.	A, C
80.	Precision temperature recorder, potentiometric type, sensitivity 0 to 1 mv. Full scale of 25 cm. chart speed 25 cm/min.	A, C
81.	Multichannel recorder with two independent recording channels each with automatic selector switch for 1 channels.	C
82.	Air and gas hygrometer for dew point temperatures - 10 to +60C (continuous recorder).	C
<u>Automatic controls:</u>		
83.	Pneumatic controller with adjustable proportional band (P action), reset time (I - action) and the rate time (D-action) all the three actions independantly adjustable (3 Nos.)	C
84.	Electrical proportional, derivative and integral controller with magnetic amplifier and servomotor.	C
85.	Amplifiers for use with transducers (6 Nos.)	A
86.	Diaphragm control valve, air operated to be used with pneumatic controls (12 Nos.)	C

(2) (3)

87. Butterfly valve to be used with electrical controls (2 Nos.) C
88. Parabolic profile valve to be used as a final control element for controlling flow of liquids (2 Nos.) C
89. Pneumatic force balance to convert pressures or differential pressures into 0.2 to 1 kgm. per sq. cm. steady output pressures for pneumatic control (2 Nos.) C

Accessories: (for Instrumentations)

90	Pressurage gauges, Dial type (Metric unit)	Nos.
	2 kg. per sq. cm.	
	76 mm	2
	152 mm	2
	229 mm	2
	305 mm	2
	5 kgm. per sq. cm.	
	76 mm	2
	152 mm	2
	229 mm	2
	305 mm	2
	10 kgm. per sq. cm.	
	76 mm	2
	152 mm	2
	229 mm	2
	305 mm	2
	25 kgm. per sq. cm.	
	76 mm	2
	152 mm	2
	229 mm	2
	305 mm	2
	Vacuum gauges 0-75 cm.Hg.	
	76 mm	2
	152 mm	2
	229 mm	2
	305 mm	2
		28
91	Vernier reading manometer (2 Nos.)	C
92.	U-tube manometers with scale and panel (24 Nos.)	A, B
93.	Dead weight gauge for calibration of pressure gauges with a standard gauge.	A
94.	Wet Gas meter with total flow indicators (4 Nos.)	C

(1)	(2)	(3)
-----	-----	-----

- | | | |
|------|--|---|
| 95. | Platinum resistance thermometer probe. | 0 |
| 96. | Gas thermometer for calibration of other thermometers. | 0 |
| 97. | Reducing valves to give constant pressures upto 15 kg/cm. on the down stream side(6-Nos.) | A |
| 98. | Reducing valve to be installed for ensuring constant pressures in the range of 0.2 to 2 kg/cm. for pneumatic controls (4 Nos.) | A |
| 99. | Differential pressure indicators, 900 mm. W.G. 2 Nos. each (4 Nos.) | A |
| 100. | Electric furnace, maximum temperature 1800 C, 30 x 60 x 30 cms. furnace working size. | A |
| 101. | Compressor for pressures upto 5 kg/cm. with storage tank, to supply compressed oil free air for all the pneumatic controls in process controls laboratory. | 0 |
| 102. | Time switches, maximum breaking capacity: 6A, 250V, A.C. single phase, different types (12 Nos.) | A |
| 103. | Variac transformers:
8 A single phase 220 volts (6 Nos.)
15 A single phase 220 volts (3 Nos.)
5 A three phase 440 volts (5 Nos.)
10 A three phase 440 volts (3 Nos.) | A |
| 104. | Voltage stabilizer 1000 watts | A |

Fuels Equipments

- | | | |
|------|--|------|
| 105. | Precision Bomb Calorimeter with full temperature compensation (2 Nos.) | A, C |
| 106. | Thermometers (Beckmann) (4 Nos.) | 0 |
| 107. | Junkers Gas Calorimeter with all subsidiary equipment and spare meter. | 0 |
| 108. | Hempel Gas Analysis Unit, complete with spares for all glass parts and magneto-spark Unit. | 0 |

(1)	(2)	(3)
109.	Redwood Viscometers No.1 and No.2. (2 No. each)	A
110.	Flash Point Unit Pensky Martin and Abel (2 Nos. each)	A
111.	Ovens for ash and Moisture (2 Nos.)	A
112.	Calorimeter for determining Heats of mixing and Heats of Reactions (2 Nos.)	C
<u>Service Workshop Equipment</u>		
113.	Precision lathe	A
114.	Gap-bed lathe with milling attachment (6" centre)	A
115.	Power Hacksaw Machine	A
116.	Pillar Drilling Machine 1" capacity.	A
117.	Shaping Machine	A.
118.	Bench Grinder	A
119.	Pipe bending machine (2" capacity)	A
120.	Sheet bending machine (30" wide for 10 gauge m.s. sheets)	A
121.	Gas welding equipment (one set)	A
122.	Electrical Welding Units a) For spot welding b) For Arc welding (one set each)	A
123.	Variety of workshop tools and portable electrical tools (as available).	A
<u>General Service Facilities</u>		
124.	Air Compressor (2 Nos.)	A
125.	Vacuum Pump (2 Nos.)	A
<u>Process Equipment</u>		
126.	High Efficiency Fractionating Unit (Glass with stainless steel packings)	B, C

(1)	(2)	(3)
127.	Tubular Flow Reactor (with tubes 3 cms. and 4 cms. i.d., 30, 70 and 90 cms. long - quartz/stainless steel.) Complete with all accessories and tubular furnace up to 1000°C with temperature control.	B, C.
128.	Fluidised bed reactor (with 4 cms. i.d. and 200 cm. high s.s. tube) with heating unit cyclone separator and compressor.	A, B, C
129.	Glass assemblages with interchangeable glass joints for preparative chemistry for oxidation, chlorination, sulphuration, nitration, distillation and absorption etc.	A
130.	Autoclaves 250 c.c. and 500 c.c. with stirring and electrical heating up to 600°C 100 psig. (one each)	C
<u>Accessories and Instruments (for laboratories)</u>		
131.	Thermostatic baths ($\pm 0.05^\circ$) (5 Nos.)	A, C
132.	Magnetic Stirrers (4 Nos.)	A
133..	Variac auto-transformers (3, 4, 8, 10, 15 Amps)	A
134.	Rectifiers for single phase (220 volts) (4 Nos.)	A
135.	Velometers (3 Nos.)	C
136.	Wet Gas meters (3 Nos.)	C
137.	Dry Gas Meters (2 Nos.)	A
138.	Rotameters (different ranges for liquids and gasses (12 Nos.)	A, C
139.	Stroboscopes (one with photographic attachment (2 Nos.)	C
140.	Voltage Stabilizers 2 k.w. (2 Nos.)	A
141.	Photomicrographic equipment (one set)	C
142.	Viscometers: different types (other than ostwald) (one each)	A, C
143.	Gas cylinders (12 Nos.)	C

(1)	(2)	(3)
144.	Small evaporating & sugar pumps (12 Nos.)	A
145.	Drafting machine	A
146.	Calculating Machine Hand Operated (2 Nos.)	A
147.	Calculating Machine Electrically operated.	C
148.	High Vacuum Equipment (1 set)	A, C
149.	Drying Oven - electric (6 Nos.)	A
150.	Refrigerators (2 Nos.)	A
151.	Balances Single Pan (2 Nos.)	A
152.	Rough Balances (various capacities) (10 Nos.)	A
153.	Stirrers, electrical, variable speeds (6 Nos.)	A
154.	Tachometers - Indicating type (4 Nos.)	C
155.	Tachometer - Recording type	C
156.	Microscopes (2 Nos.)	C
157.	Microscope Travelling (2 Nos.)	A
158.	Microscope Metallurgical	C
159.	Psychrometers (4 Nos.)	C
160.	Thermocouples with dial indicators (6 Nos.)	A
161.	Reduction Gear Unit (6 Nos.)	A
162.	Time switches (12 Nos.)	A
163.	Sun-vic or similar type controls (12 Nos.)	C
164.	Refractometers (2 Nos.)	A
165.	Stop-clocks/stop-watches (12 Nos.)	A
166.	Tubular Rheostats (24 Nos.)	A
167.	Condensing Units - 2 tons capacity (2 Nos.)	C
168.	Analytical balances (6 Nos.)	A
169.	Selected electrical measuring instruments (50 Nos.)	A
170.	Electrical-Multimeters (2 Nos.)	A

(2)

170. ~~Gas~~ Mantles and tapes (20 Nos.)
172. ~~Gas~~ phase chromatographic Unit.
173. ~~Gas~~ potentiometers with standard ~~cell~~ and galvanometer.
174. ~~Gas~~ cell
175. ~~Gas~~ recorders (3 Nos.)
176. ~~Gas~~ (3 Nos.)
177. ~~Gas~~ (2 Nos.) (Photo-electric)
178. ~~Gas~~ generator Unit
179. ~~Gas~~ (KWH) (6 Nos.)
180. Amplifier
181. Spectroscope
182. Strip projector
183. 'Blue- printing' machine
184. Drawing instruments (2 sets)
185. Surface/interfacial Tension Apparatus
186. Vacuum drying ovens (2 Nos.)
187. Photographic equipment (1 set)
188. Drop Counter
189. Analogue Computer
190. Polarograph Recording
191. Contact Thermometers (3 Nos.)
192. Conductivity bridge, cells & recorder
193. Rotary Vacuum Pumps - 3
194. Portable Compressors (2 H.P.) - 2.

(1)	(2)	(3)

195.	Hot air torch for plastic welding.	A
196.	Platform scales (1 cwt) 2	A

Central Facilities in the Institution to be made available for the Chemical Engg. Deptt.

Infra-red spectro-photometer.
Ultra-violet "
Spectroscopic equipments
Computer Services.
Glass Blowing
Instrument repair service.
General Workshop Services.



सत्यमेव जयते

LIST OF EQUIPMENT AND INSTRUMENTS REQUIRED FOR THE VARIOUS ELECTRICAL ENGINEERING LABORATORIES FOR UNDER GRADUATE COURSES.

SYMBOLS:

- A = Items indigenously available.
 B = Items to be assembled by colleges
 C = Items to be imported.

Basis: Three laboratory courses: 3 Hours week each
 for one year, 60 students for each course,
 12 Groups each of 15 students.

Electronics (Service laboratory):

S. No.	Item	Quantity	Category
1.	R.L.C. Bridge	1	A
2.	Tube Tester	1	A
3.	Transistor tester	1	A
4.	R.C. Oscillators	6	A
5.	Beat Frequency Oscillators	2	A
6.	Vacuum Tube Voltmeters	6	A
7.	R.F. Oscillators	2	A
8.	Regulated Power Supplies (300 V)	6	A
9.	Regulated Power supplies (25 V)	6	A
10.	Cathode Ray Oscillograph Single beam (I.F.C.)	6	A
11.	A.F. Output meter	1	A
12.	Wide Range Millivoltmeter	2	A
13.	Multimeters	6	A
14.	D.C. Voltmeters, Various Valves	24	A
15.	D.C. Millimeters, various valves	24	A
16.	Electronic Switch	6	A
17.	Double beam Oscillograph	1	A
18.	Substitution boxes E and C	24	A
19.	Soldering guns	6	A
20.	Miscellaneous items	As required	A

Machines Laboratory

S.No.	Name	Quantity	Category
1.	2.	3.	4.
1.	A.C. Motors driven D.C. Generator set 250 V, 40 KW, with control gear and panels or Silicon or Selenium type rectifier of the same rating	1 Unit	A
2.	A.C. Motor driven D.C. Generator set, 50 volts, 100 A with control gear and panel or Silicon or Selenium type rectifier of the same rating	1 Unit	A
3.	Two similar coupled shunt machines with at least 20% compounding 230 volts upto 5 K.W. provided with field regulators etc. One provided with suitable starter	1 Set	A
4.	Two similar coupled shunt machines 230 volts upto 5 HP provided with suitable starters and field regulators etc. (one of the machine to be provided with dynamometer fittings)	1 set	A
5.	Self starting synchronous-motor (400-volts, 3-phase) driven compound generator 230 volts, 7.5 K.W. provided with necessary starting and control gears	1 Set	A
6.	Two similar coupled D.C. series machines 230-volts upto 6.5 H.P. provided with suitable starter. Field regulators, detachable fly- wheel, drum controller etc., with overspeed protection and loading arrangements.	1 Set	A
7.	3-Phase 400 volt 5 H.P. slip ring induction motor complete with starter, coupled to a 230 v. D.C. shunt generator.	1 Set	A

1.	2.	3.	4.
8.	5 H.P. D.C. compound motor 230 volts with brake drum, with starter and field regulator	1	A
9.	3 H.P. D.C. Series motor with brake drum with starter and over speed protection.	1	A
10.	2 K.W., 230-V Amplidyne coupled to a D.C. shunt machines	1 Set	A
11.	Synchronous Generator 400 volts, 3 phase, 50 cycles 5 to 7.5 KVA coupled to a suitable 230 volts, D.C. shunt motor the D.C. side to be provided with dynamo- meter fitting.	2 Sets	A
12.	Induction Motor Cascade set comprising a 3-Ph. 400 V. 50 cps slip ring Induction Motor upto 5 H.P. with starter and auxiliary equipment an auxiliary motor, coupled to 230-V D.C. dynamometer - preferably a 4/m/c set the 4th machine being a phase advancer.	1 Set	A
13.	3-Phase 400 volts 50 Cycles upto 5 H.P. cage induction motor with stardelta starter and brake drum.	1	A
14.	3-Phase 400 V. 50 cycles, 1500 r.p.m. 5 H.P. double cage induction motor with auto-transformer starter, braking arrangements etc.	1	A
15.	3-Phase 400 V. 50 cycles, 5 H.P. slip ring induction motor with resistance starter, dynamometer at one end and brake drum at the other end.	1	A
16.	3 Phase 400 V, 50 cycles variable speed commutator motor of the schrage type with p.f. adjustments, upto 7 H.P. with tappings brought out and equipped with suitable starter brakedrum.	1	A

1.	2.	3.	4.
17.	3 phase 400-V 5 H.P. 50 cycles squirrel cage motor with starter wound for winding study and suitable for connection as pole changing motor with brakedrum.	1	A
18.	3-Phase, 230-V, 1 H.P. capacitor start induction motor with brakedrum	1	A
19.	230 V, 1 HP single-phase repulsion motor with brakedrum	1	A
20.	230 V, 1 HP universal motor with brakedrum	1	A
21.	7.5 HP Generalised Machine coupled to a D.C. machine, with auxiliaries (CEMEC)	1 Set	A
22.	Single-Phase transformer 230 V 50-cycles, 2 to 3 KVA. 1/1 Ratio with facilities for sectionalising both primary and secondary in two equal halves & provided with taping at 86.6% on one side, suitable for Scott connection.	6 Nos.	A
23.	Single-phase 230/0-270 V. 50-Cycles 5 KVA variac	3	A
24.	3-Phase, 25-A, silicon controlled rectifier unit for rectification inversion and frequency changing	1 Unit	B
25.	3 Phase 400/0-450 V, 50 cycles 10 KVA variac	3	A
26.	Single Phase 230/0-270 V, 50c/s 3 KVA Variac.	6 Nos	A
27.	Moving Iron Voltmeters	12	A
28.	Moving Iron Ammeters	12	A
29.	Synchrosopes	2	A
30.	Recording Ammeter	1	C
31.	Recording Voltmeter	1	C
32.	Recording wattmeter	1	C
33.	C.R.O. beam with D.C. to 10 K C/s with long persistance screen and electronic switch.	3	C

1.	2.	3.	4.
34.	One motor driven camera attachment with adapters for various types of oscilloscopes.	3-1	C.
35.	Circuit Breakers for different laboratory circuits.	L.S.	A
36.	Single pole, double pole triple pole knife switches and iron clad switches for the various equipment in lab.	L.S.	A
37.	Switch board panels of various sizes with wiring cleats and accessories	L.S.	A
38.	Wire wound rheostats of various ranges (from 100 to 1000 Watts)	50	A
39.	3-Phase Choke	1	A
40.	Megger 500 V and 1000 V	1 each	A
41.	Bridge Megger	1	A
42.	Earth Tester	1	A
43.	Stop Clocks	6	A
44.	Tachometers	9	A
45.	Energymeter (different types)	6	A
46.	Chrono-counters	3	A
47.	Terminals Brass Screws etc.	L.S.	A
48.	Stroboscopes	2	A
49.	Clip-on ammeter	2	A
50.	House Wiring demonstration panel	2	B
51.	Automobile electrical equipment panel	1	A
52.	Demonstration units and models	L.S.	B or C
53.	Battery charger and accessories	1 Set	A
54.	Torque meter	1	C
55.	Point-on-wave switch	1	C or B



1.	2.	3.	4.
56.	Torque-angle recorder	1	C or B
57.	Different types of transducers	L.S.	C
58.	Tachogenerator with recorder	1	C
59.	Accelerometer	2	C
60.	Portable D.C. Moving Coil Ammeters of various ranges.	50	A
61.	Portable moving iron ammeters of various ranges.	50	A
62.	Portable D.C. Moving Coil volt-meters of various ranges	50	A
63.	Portable iron voltmeters of various ranges.	50	A
64.	Portable thermocouple & hot wire meters:		
	Ammeters and Voltmeters	6	C
65.	Rectifier type meters: Ammeters and Voltmeters	6	A
66.	Portable dynamometer wattmeters upf single phase of various voltage and current ratings.	10	A
67.	Portable dynamometer wattmeters upf single phase of various voltage and current ratings precision type.	2	C
68.	Portable Dynamometer Wattmeters LPF single phase of various voltage and current ratings.	8	A
69.	Portable Dynamometer Wattmeters LPF single phase of various voltage and current ratings precision type.	2	C
70.	Portable 3-phase wattmeters of various current and voltage ratings.	6	A
71.	Single phase portable power factor meter.	1	A
72.	3 Phase portable power factor meter.	1	A
73.	Frequency meters	2	A

1.	2.	3.	4.
74.	Phase sequence indicator	1	A
75.	Sound level meter	1	C
76.	Relays of different types (over-load inverse time, earth leakage, reverse power, thermal, differential)	1 Set	C
77.	Portable relay testing unit	1 No.	B or C
78.	Model transmission Line	1 Unit	A or B
79.	Miniature circuit breakers	L.S.	A
80.	Models of power stations	L.S.	A
81.	Cut-away specimens of cables	L.S.	A
82.	Miscellaneous items like suspension insulators, shackle insulators.	L.S.	A
83.	Phase shifter with 400-V, 3 Phase stator and 230-V single-phase rotor	2	A
84.	Single phase variac 230-V input and 0 to 270 volts output	2	A
85.	3-phase induction regulator, 3-phase, 50 C/s.	1	A
86.	Electrical Calculator	1	A
87.	D.C. NETWORK Analyser with six generating station elements.	1	B
88.	Positive, negative and zero sequence voltage and current filters and meters.		B
89.	Special relays	L.S.	B

Circuits Laboratory

S. No.	Name	Quantity	Category
1.	Single Beam Oscilloscopes	6	A
2.	Double Beam Oscilloscope	2	A
3.	A.F. Signal (Generators) (Sine/Square)	6	A
4.	VTVM's	8	A
5.	Multimeters	8	A
6.	Voltmeters	12	A
7.	Ammeters	12	A
8.	A.C. Milivoltmeter	2	A
9.	D.C. Milivoltmeter	1	A
10.	Single-phase Wattmeters	4	A
11.	Single-phase Wattmeters (LPF)	2	A
12.	RLC Bridge	1	A
13.	D.C. Regulated Power Supply	2	A
14.	Decade Resistance Boxes	6	A
15.	Decade Capacitance	6	A
16.	Variable Induction	2	A
17.	Phase Sequence Indicator	1	A
18.	Pulse Generator	1	A

Basis: Intake 30 students in communication
Engineering 15 students in a Batch; 3 hours/
week.

MICROWAVE LABORATORY

1.	X-Band Microwave test bench including generator, attenuator, slotted-line, SW detector.	4 Nos.
2.	Waveguide components (Bends, Twist Tees, Directional Couplers, Moveable Shorts, Loads, Screw Turners, Phase Shifts).	Lump-sum
3.	Cavity Wavemeters (different types)	4
4.	Bolometer (Microwave Power Meter) with Bolometer elements (different types).	2
5.	Microwave amplifier (travelling wave tube).	1
6.	Microwave signal generator S. band	1
7.	Microwave signal generator X-band	1
8.	Klystron Power Supply Unit.	4
9.	VSWR Meter	4
10.	Square Wave Generator	2
11.	Ferrite Isolator	1
12.	Circulator	1
13.	Meters (voltmeters, Milliammeters, Microammeters).	L.S.
14.	G.R. Unit Oscillator (diff. frequencies)	4
15.	G.R. Power Supply Unit (for unit Oscillator).	2 sets
16.	Coaxial Slotted Line with all components wavemeter.	2 sets
17.	Precision attenuator for x-band	2
18.	Variable Calibrated attenuator for x-band	2
19.	Sectoral horn	2
20.	Pyramidal horn	2

21.	Consumable stores and components. (Klystrons, crystal detectors, tunable probes, bolometer elements, crystal mounts, Bolometer-mounts klystron mounts, coaxial cable BNS connectors varactor diodes, ferrite rods and slabs, microwave dielectric materials, brass and copper sheets etc.	L.S.
22.	Multimeter	3
23.	VTVM	3
24.	Magnetron with associated magnet & line pulser	1 unit
25.	VHF Bridge	1
26.	Ratio Detector	1
27.	Reflectometer	1
28.	Z-meter	1



S. No.	Name of the Item.	Quantity	Category
1.	2.	3.	4.
1.	Constant voltage transformer 3 KVA, 230 V	1	A
2.	400 C/s supply source		
	a) Motor generator set.	1	A
	b) Power Oscillator.	1	A
3.	Low voltage D.C. Power Supply (0-50 V, 0-100 mA)	2	A
4.	Variable Regulated DC Power Supply unit		
	a) Transistorized.	2	A
	b) Tube	4	A
5.	Low Frequency Oscillator (0-001 to 1 Kc/s with different wave forms)	2	A or B
6.	V.T.V.M. (Multirange,	4	A
7.	Oscilloscopes low frequency high persistence screen		
	a) Single beam	2	C
	b) Double beams (with recording arrangement)	2	C
8.	X-Y Recorder	1	C
9.	Wave Analyser (low frequency)	1	C
10.	Low frequency Phasemeter	1	B
11.	Difference Amplifier.	2	B
12.	Chopper Stabilized D-C Amplifier.	2	A
13.	Servo amplifier with phase shifting network	2	A
14.	Magnetic Amplifier	1	A
15.	Analog computer Demonstration unit	1	A

16.	Electrolytic Tank.	1	B
17.	Desk calculator		
	Electrical	1	A
18.	D.C. Position Control Unit	1	O
19.	A.C. Position Control Unit	1	O
20.	(a) Modulators.	3	A
	(b) Demodulators.	3	A
21.	Amplidyne Set 1.0 K.W.	1	O
22.	Double channel Time base recorder	1	O
23.	Servo Analyzer with scope.	1	O
24.	L.F. Phase Shifting Unit	2	A or B
25.	Hydraulic Position Control Demonstration Unit	1	O
26.	Synohros		
	(a) Transmitter	4	O
	(b) Control Transformer	4	O
	(c) Differential Synohro	4	O
	(d) Resolver	4	O
27.	Servomotors		
	(a) A.C. (5 to 100 W) 50 o/s to 400 C/S	6	O
	(b) D.C. (5 to 100 W)	3	O
	(c) D.C. Split field (5 to 100 W)	3	O
28.	Decade Resistance Box	2	A
29.	Decade Capacitance	2	A
30.	Decade Inductor	2	A
31.	(a) D.C. Milliammeter	4	A
	(b) A.C. Microvoltmeter.	1	A



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ELECTRICAL WORKSHOP

No.	Name	Quantity	Category
1.	Lathe		A
2.	Vertical drilling machine		A
3.	Electrical hand-drills	six	A
4.	Coilwinding machine		A
5.	Sheet bending machine		A
6.	Printed circuits Fabrication Unit		A
7.	Grinder		A
8.	Bench Vice and Tools		A
9.	Growler		A
10.	Notching Press		A



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LIST OF SCIENTIFIC EQUIPMENT AND INSTRUMENTS REQUIRED
IN AERONAUTICAL EDUCATION IN INDIA AT ALL LEVELS

S. No.	Item	Nos. required	Where available	Can this be fabricated in this country.	Remarks
1	2	3	4	5	6

AERODYNAMICS AND FLIGHT MECHANICS

1*	3-dim smoke tunnel 45 x 45 x 90 cm	1	I.I.T.K. & I.I.Sc.B.		
	(a) flood lights	12	F	Can be improvised locally	
	(b) manometer	1	Indigenous	Wolf Tools	
	(c) multimanometer	1	"		
	(d) stroboscopes	1	"	Phillips	
	(e) 5 KW motor D.C.	1	"	Kirloskar	
	(f) 5 KW rectifier	1	"	Bejay	
	(g) blower	1	"	Wolf Tools	
	(h) smoke generator	1	I.I.T.K./ I.I.Sc.B.		
2*	90 cm x 90 cm x 250 kph W.T. (wind-tunnel)	1	I.I.T.K./ I.I.Sc.B./ N.A.L.B.		
	(a) wind tunnel balance (mech)	1	Indigenous	Can be made locally	
	(b) wind tunnel balance (str. gage)	1	NAL, B.		
	(c) micromanometer (projection)	1	Indigenous, IISc.		
	(d) multimanometer	1	I.I.T.K./ I.I.Sc./ NAL, B.	Can be made locally.	

* minimum requirement; IISc - Indian Institute of Science; NAL - National Aeronautical Laboratory

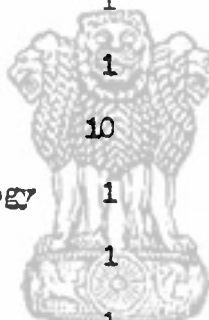
I - Indigenous; IITK - Indian Institute of Technology, Kanpur

F - Foreign, TIFR - Tata Institute of Fundamental Research

1.	2.	3.	4.	5.	6.
(e) high speed motors for V/ STOL	2	F			
(f) 30 KW motor system D.C. or slipping A.C.	1	I		Kirloskar	
(g) cathetometer	1	I		Andhra & Punjab	
(h) rectifier 30 kw	1	I		Bajaj	
3. 3 cm x 8 cm supersonic tunnel	1	I, IISo./NAL			
(a) schlierene system	1	NAL			
(b) light source	2	F			
(c) aircompressor 10 kw	1	I			
(d) dryer	1	NAL			
(e) storage tank 500 cft.	1	I			
(f) pressure gauges 0-200 lb/ sq.in.	3	I			
(g) optical glass		F			
(h) mercury manometer	1	I			
(i) drag balance	1	NAL			
(j) fortin's barometer	1	I			
4. 4 cm x 15 cm supersonic tunnel	1				
(a) schlieren system	1	NAL/IISo.			
(b) light source	1	F			
(c) aircompressor 30 kw	1	I			
(d) dryer	1	I			
(e) storage tank 500 cft	1	I			
(f) pressure gauges 0.200 lb/sq.in.	3	I			
(g) optical glass		F			
(h) mercury manometer	1	I			
(i) drag balance	1	NAL			

1.	2.	3.	4.	5.	6.
	(j) camera	1	F		
	(k) high pressure valves	3	I & F		
	(l) high pressure pipes		I & F		
	(m) wet & dry bulb thermometer	1	I		
	(n) mercury	1	I		
	(o) glass tubing	1	I		
5.	100 cm x 150 cm x 700 kph W.T. (wind-tunnel)	1	I		
	(a) strain guage balance	1	NAL		
	(b) manometer	1	I		
	(c) multimanometer	1	I		
	(d) cathetometer	1	I		
	(e) megger	1	I		
	(f) 1000 kw motor system	1	I		
6.*	15 cm sq. water tunnel	1	I		
7	100 cm x 150 cm plotting tank	1	I		
3.	60 cm x 60 cm x 250 kph low turbulence tunnel	1	I		
	(a) micromanometer	2	I		
	(b) 30 KW motor system	1	I		
	(c) rectifier 40 KW	1	I		
	(d) hot wire amplifier	1	NAL, & I.I. So.		
	(e) oscillator	1	I		Phillips
	(f) oscilloscope	1	I		Phillips
	(g) wave analyser		F		
	(h) oscilloscope camera	1	F		
	(i) hypodermic tubing		I		Industrial Estate, Kanpur

1.	2.	3.	4.	5.	6.
(j) platinum wires			F		
(k) tungsten wire			F		
(l) avometer	1	I	Phillips		
(m) microscope x 50.	1	I	Lawrence & Mayo Native Inst.. For		
(n) miniature soldering iron	2	I			
(o) micrometer heads	6	I			
9 15 cm dia. or sq. shock tube		I	Can be made locally.		
(a) recording camera	1	F			
(b) Hivao pumps	2	I			
(c) Moleod gauge	1	I	Can be made locally		
(d) pirani gauge	1	I	" "		
(e) pressure transducer	10	I	NAL		
10. Water table for Hydraulic Analogy	1	I	Can be made locally.		
11.*Heleshaw Apparatus	1	I	" "		
12.*Reynolds Transition Apparatus	1	I	" "		



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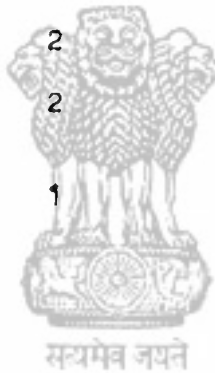
1.	2.	3.	4.	5.	6.
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STRUCTURES

1*	Universal Testing Machines 10 tons	1	F. Hungarian	
2.*	Torsion Testing Machine	1	F. Hungarian	
3.*	Fatigue Testing Machine	1	F. Hungarian	
4.*	Impact Testing Machine	1	F. Hungarian	
5.*	Hardness Tester	1	F. Hungarian	
6.	Creep Testing Machine 1000 kg. 0-400°C	1	F	
7.	6" Photoelastic Bench	1	Polaroids imported. Rest can be made in Lab.IIs, IITK	
	(a) Loading frames			
	(b) Light source			
	(b) Camera			
8.*	Resins for Models		Bakelite Corp. India	
9.*	(a) Strain Indicator		NAL	
9.*	(b) Switching Unit			
10,	Strain Gauges			
	*(a) Wire gauges		NAL, Rohits, Banaras, IIT	
	(b) Foil Gauges			
	(c) Capacitance Gauges		High tem-gauges to be imported	
	(d) Photoelastic Gauges			
	(e) Cement			
11.*	Extensometer			
	(a) Mechanical	4		Can be made in India
	(b) Electricals	2		Can be made in India
12.*	Dial Gauges	36	India	
13.	Prooving Rings			
	*(a) Calibration	1	F	Can be made in India
	(b) Other purposes	12		



1.	2.	3.	4.	5.	6.
14.	Hydraulic Jacks 100-2000 lbs.	6 in each range	India		
15.	Micrometers	12	India		
16.	Magnetic Bases	24	India		
17.	Vibration exciter				
	(a) 5 - 10 lbs.	2	F	Can be made in India	
	(b) 10 - 20 lbs.	2	F	Can be made in India	
	(c) 20 - 100 lbs.	2	F	Can be made in India	
18.	Oscillators				
	(a) Audio frequency	2	India		
	(b) 0 - 100 cycles	2	I		
19.	Power Amplifiers	2	India		
20.	Recorders	2	F.		
21.	Multichannel Strain Recorder	1	F. Digital output on cards or tape required.		
22.	Al.alloy Sheets				
23.	Steel Sections				
24.	Brass Rods				
25.	Load cells			NAL	
26.	Brittle Lacquer			IITK; India	
27.	Moire Fringe Unit	1		Can be made local	
28.	Displacement Pickups	6		NAL	
29.	Voltage Stabiliser	1	I		
30.	Travelling Microscope	1	I		
31.	Perspex Sheets		I		
32.	Multimeter	2			
33.	Vibration meter with probe	1	F		



1.	2.	3.	4.	5.
34.	Dial Potentio meter	6	I	
35.	Sheet bending machine	1		
36.	Shearing Machine	1		
37.	Rivetting Equipment	1 set		
38.	Flutter Tunnel	1		
39*	Sheet Buckling Apparatus	1		
40.*	Shear Lag and Shear Centre Apparatus	1		



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1.	2.	3.	4.	5.	6.
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PROPULSION

1.*	30 cm x 90 cm x 250 kph cascade tunnel	1	I	
	(a) 30 kw motor system	1	I	Kirloskar
	(b) 30 kw rectifier	1	I	Bajaj
	(c) micromanometer	1	I	IISc
	(d) multimanometer	1	I	Can be made locally
	(e) Fortin's Barometer	1	I	
	(f) micrometer	2	I	
2.*	2 dim. smoke tunnel 5 cm x 100 cm x 150 cms	1	I	
	(a) smoke generator	1	I	IITK
	(b) strobotac	1	I	Phillips
	(c) flood lights	12	F	
	(d) 5 kw motor D.C.	1	I	Kirloskar, Bajaj
	(e) manometer	1	I	Can be made locally
	(f) 5 kw Rectifier	1	I	Bajaj
3.*	Jet engine with axial flow compressor	1	F	
	(a) dynamometer	1	F	
	(b) torque meter	1	F	
	(c) thrust stand	1	F	
	(d) manometer	1	I	Can be made locally
	(e) fuel flow motor	1	F	
	(f) instrumentation		F	
4.*	centrifugal compressor	1	I	Steel Plant Ltd., Bombay
	(a) instrumentation		I	
	(b) teohnometer		I	

1.	2.	3	4	5.	6.
5.	Detonation shock tube	1	I	Can be made locally	
	(a) spectroscope	1	F		
	(b) high vac. pumps 1 micron Hg.	2	F		
	(c) pressure transducers	10	F		
	(d) oscilloscopes	2	F.I.	Phillips, TIFR	
	(e) recording camera	1	F		
	(f) electronic counter	1	F		
	(g) other instrumentation				
6.	Solid Propellant Grinder	1	I		
	(a) Solid Propellant Mixer	1	I		
	(b) Periscope	1	I		
	(c) Hand Gloves	3 pairs	I		
	(d) Gas Masks	3 Nos	I		
	(e) Sieves	12	I		
	(f) Crawford Bomb	1	I	Can be made locally.	
	(g) Thrust stand upto 50 lbs	1	I		
	(h) Timer	1	I		
	(i) Telescope & Binoculars	1	I		
	(j) Fire extinguishers	2	I		
	(k) Pyrometers Optical	1	F		
7.	Liquid Rocket Motor	I	F		
8.	Combustion Chambers		I	Can be obtained from old air r	
9.	Heat Exchangers		I	Can be made locally	
10.	Subsonic Ramjet Unit		F		
11.	Exploded views of Engines		I		
11.	Exploded views of Engineers		I		

1.	2.	3.	4.	5.
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S Y S T E M S

1.*	Airspeed Indicator	2	F	Can be made in India
2.	Operational Amplifiers	6	F	
3.	Anology Computers	1	F	
4.*	Accelerometer	2	F	Can be made in India
5.*	Turn and Bank Indicator	2	F	" "
6.*	Gyro Compass	1	F	" "
7.*	Altimeter	2	F	" "
8.	Selsyn Transmitter, Receiver	6	F	" "
9.*	Directional Gyro	1	F	" "
10.*	Rate of Climb Indicator	2	F	" "
11.	Air pressure transducers 30 to 600 mph	2	F	" "
12.	Position transducer	12	F	" "
13.	Acceleration transducer	2	F	" "
14.	Temp. transducer	6	F	" "
15.	Yaw meter	2	F	" "
16.	Tele metering equipment	1	F	" "
17.	Precision Manometer Hg.	2	I	Can be made locally
18.	Mach Meter	1	F	Can be made in India
19.	Artificial Horizon	1	F	Can be made in India
20.	Electronic Counters	1	F	" "
21.	Booster Fuel Pump	1	F	Can be obtained from rejected aircraft
22.	Fuel Flow meters	1		" "
23.	Typical Control System	1		" "
24.*	Engine Propeller Test Rig	1		" "
25.*	Typical Hydraulic System Layout	1		" "
26.*	Typical Pneumatic system Layout	1		" "
27.*	Oleo Pneumatic Shock Absorber	1		" "

1.	2.	3.	4.	5.	6.
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GENERAL AND SUPPORT FACILITIES

1.	Precision Lathe 4' bed	1	I	HMT, Kirloskar
2.	Wood Working Lathe 4'	1	I	
3.	General Purpose Lathe 4'	1	I	
4.	Jewellers Instrument Lathe	1	I	
5.	Vertical Drilling Machine	1	I	
6.	Tool Grinder & Buffer	1	I	
7.	Milling Machine Universal	1	I	
8.	Spot welder	1	I	
9.	Arc Welder	1	I	
10.	Gas Welding set	1	I	
11.	Stainless steel Sheets, Bar		I	
12.	CM Steel Sheets, bars		I	
13.	Micrometers		I	
14.	Calipers		I	
15.	Surface Plates		I	
16.	Band Saw		I	
17.	Portable Sander		I	
18.	Circular Saw		I	
19.	Drills		I	
20.	Milling Cutters		I	
21.	Metal Cutting Power Saw		I	
22.	Vacuum Tube Voltmeter	1	I	
23.	Standard Cells	2	I	
24.	Ammeters	6	I	
25.	Voltmeters	6	I	
26.	Planimeters	2	I	
27.	Variac transformers	3	I	



1.	2.	3.	4.	5.	6.
28.	Desk Calculators (Electrical)	3		Facit - Madras	
29.	Precision potentiometers	6		India	
30.	Lathe Surfacing sliding and screw cutting 6'	1		I	
31.	Nibbling machine	1		I	
32.	Hydraulic press 100 ton	1		I	
33.	Anodizing plant	1		I	
34.	Salt bath	1		I	
35.	Argon arc welding	1		F	
36.	Heat treatment furnace	1		I	
37.	Bending brakes	1		I	
38.	Tool makers microscope	1		I	
39.	Non-destructive crack detection equipment	1		I	
40.	Precision Casting Equipment	1		I	
41.*	Facit electric desk calculator	2		I	
42.	Frident electronic calculator	1		I	
43*	Drafting machines	6		I	

LIST OF EQUIPMENT AND INSTRUMENTS REQUIRED FOR THE VARIOUS MECHANICAL ENGINEERING LABORATORIES FOR UNDER GRADUATE COURSES.

Unit: One Laboratory

Classification for procurement:

The instruments required are divided into four categories. They are:

- A. Items available indigenously from industrial manufactures.
- B. Items that can readily be manufactured by all engineering colleges in their own workshops.
- C. Items that are to be imported for the present.
- D. Items that are already developed as some institute or can be developed at selected engineering colleges with blue prints being made available for mass manufacture for other colleges.

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- A. FLUID MECHANICS AND FLUID MACHINERY
(Sections I, II and III are interrelated and should be housed together)

- I. Incompressible Flow:

Item	Nos.	Category
1. Two pumping sets for supply of water to the Laboratory - (a) 600 gpm, (b) 1100 gpm. Head for 40 feet head	2	A
2. Under ground water supply reservoir 15,000 gallons approximately.	1	B

3. Constant head (overhead) tank with a skimming weir to maintain constant head within 2%, tank capacity 8000 gallons.	1	B
4. Volumetric calibration unit for water of 2500 gallons capacity with provisions to connect individual equipment through a three - way diverter.	1	B
5. Pipes and pipe fittings for connecting the overhead and underground tanks and connecting the overhead tank to individual experiments.	As required	A
6. Orifice plates and venturimeters of different sizes for main supply lines to individual experiments.	As required	A,B
7. Hand tools and pipe fitting tools such as pipe cutters, dies, pipe vice etc.	Lump Sum	A
8. 100 Kg dial type platform scale.	1	A
9. 200 ft. of 4" diameter flexible rubber hose	1	A
10. Flexible plastic tubing, modelling clay, A clear perspex sheet, perspex tubes, rigid P.V.C. pipes, hypodermic tubing, aluminium powder etc.	As required	A
11. Inclined manometers, multitude manometers (with pressure lock device); U-Tube manometers, differential manometers micromanometers, piezometers, pressure and vacuum gauges etc. of different ranges and with different manometer fluids.	As required	A,B,C
12. Point gauges, hook gauges including electric contact gauges.	As required	A
13. Pitot tubes, Pitot-Static tubes, static pressure probes and keil tubes.	As required	A,B
14. Assorted instruments, such as stop watches, meter scales, thermometers, tachometers, wattmeters, ammeters, voltmeters, stroboscope, planimeter, revolution counters (reversible and zero reset type), micrometers, vernier calipers etc.	As required	A

15.	Current meters for measurement of water velocity - cup type and propeller type with digital readout and different ranges including micro-current meters.	Two of each type	A
16.	Deadweight pressure gauge tester.	1	A
17.	Instruments to measure fluid properties, such as: Viscosity, Surface tension, Specific Gravity and Elasticity.	One of each type	A
18.	Low rpm fractional horsepower universal motors	3	A
19.	Assorted instruments for wind tunnel: Boundary layer mouse, three-component subsonic balance, shear meter (Preston tube or floating type), thermocouple wire and temperature recorder, manually operated constant - temperature type mean velocity hot-wire anemometer bridge along with probes, 0.001 in. diameter platinum wire, strain gauge or capacitance type pressure transducer and accessories, double-beam oscilloscope.	One of each type	D
20.	Assorted instruments for studying water waves: wave generator, instruments to measure frequency and amplitude of waves, capacitance gauges and accessories for wave height measurement.	One of each type	C,D
21.	Flumes: (a) 6" wide x 18" deep x 10' long, tilting type; (b) 12" wide x 18" deep x 60' long tilting type. Water to both flumes to be supplied from overhead tank as one of the experimental pumps included in Turbomachinery list.	Two	B
22.	Hydraulic model tray 8' x 8' x 12" along with two pumps and models of hydraulic structures, such as barrages, side channel spillway, aqueduct, fall etc.	1	D
23.	Flow visualization tank - closed circuit unit 24" wide x 4" deep x 5' long with supply pump capable of producing 1" depth of water over the glass bottom of tank and assorted models.	1	D
24.	Subsonic Wind Tunnel 12" x 12" x 5' along with a 10 hp motor driven axial flow fan and necessary damper speed control.	1	D
25.	Small portable smoke tunnel with necessary models and smoke generator.	1	D
26.	Apparatus for verification of momentum principle by studying impact of jet on vanes of different types.	1	D

- | | | |
|---|---|-----|
| 27. Apparatus for studying curvilinear flow in two - dimensional or axisymmetric conduits thereby studying the energy equation and the phenomenon of cavitation. | 1 | D |
| 28. Apparatus for measuring rates of flow of air and water by means of orifice meters, venturi-meters, nozzles, Rotometers (500 litres/hour for liquids and 1000 litres/hour for air) etc. thereby studying their characteristics and calibration techniques. | 1 | B |
| 29. Apparatus for studying the characteristics of sharp - crested weirs and orifices including a constant head tank, steadying tank and measuring tank, and different types and sizes of notches and orifices. | 1 | B |
| 30. Apparatus for studying transition losses in pipe fittings such as bends, valves, sudden expansion, sudden contractions, nozzles, orificemeters, branching pipes etc. | 1 | B |
| 31. Oil recirculating unit for studying laminar flow through pipes. | 1 | D |
| 32. Turbulent air pipe for studying turbulent flow through pipes. | 1 | B |
| 33. Pipe friction study; items 32 and 31 plus long pipe for water flow. | 1 | B |
| 34. Apparatus for measurement of water hammer surge in pipe line with necessary instrumentation to measure and record fluctuating pressures. | 1 | A,B |
| 35. Electrical analogy apparatus along with 10 volts AC supply at 10,000 cps, a null detector and a wheatstone bridge. | | |
| or | | |
| Teleditimus paper for electrical analogy | - | C |
| 36. Apparatus for studying superposition of elementary plane potential flow patterns | 1 | B |
| 37. Submerged jet apparatus for air in air. | 1 | D |
| 38. Submerged jet apparatus for water in water | 1 | B |

NOTE: Item 12, 15, 20, 21(b) 22, 29 only required if the laboratory for Civil and Mechanical Engineering is together. In case the Civil Engineering Deptts. have a separate laboratory these items should be dropped and items 1, 2, 3, 4 should be reduced in size.

II. Compressible Flow

<u>Item</u>	<u>Nos.</u>	<u>Category</u>
1. 1" x 3" blowdown type supersonic wind tunnel with necessary dryer and compressed air supply system and interchangeable nozzle blocks for about three Mach Numbers.	1	B
2. Hydraulic analogy table with accessories for Fanno flow study.	1	D
3. Multipurpose thrust stand consisting of air supply (300 cfm, 100 psia) a null type laboratory balance and plenum chamber with a variety of interchangeable nozzles and ducts for studying isentropic flow, adiabatic choking etc. and to demonstrate difficulties in stagnation temperature measurements etc.	1	D
4. Constant pressure air tank for supply to above experiments.	1	B,4
5. Instruments for compressible flow work; Continuous light source Schlieren apparatus, shadowgraph equipment, necessary camera equipment for Schlieren photography, various types of manometers (as for Incompressible Flow).	One of each type	C,D

III. Turbomachinery

1. Centrifugal pump with variable speed drive, 250 gpm at 60 ft head.	1	A
2. Francis turbine with dynamometer to work at 5 ft head, 5 hp, 1250 rpm. Water to be supplied from overhead tank.	1	A
3. Pelton wheel with dynamometer, 5hp at 200 ft head. Water to be supplied by a suitable centrifugal pump-motor set.	1	A
4. Kaplan turbine with dynamometer and oil pressure governor, 5hp at 15 ft head. Water to be supplied by a suitable axial flow pump - motor set.	1	A
5. Axial flow variable pitch pump with variable speed drive, 5 cfs at 20 ft. head	1	A
7. Assorted runners of pumps and turbines - wooden models.	Lump Sum	A

8. Equipment such as pumps, valves etc. for dismantling and refitting exercises	Lumps Sum	A
9. Centrifugal and axial flow fan test rig to study fan laws.	One of each type	A
10. Fluid coupling and torque converter	One of each type	A
11. 6" x 6" x 5' blower type cascade wind tunnel (air drive provided from existing blower or compressor)	1	D
12. Assorted instruments for turbomachinery: Yaw probe, claw probe, manometers, tachometers, flow measuring devices (most of these will be common with section A I).	Lump Sum	A,B,D
14. Experimental Gas Turbine with instrumentation.	1	A,C
15. Low Pressure hot air turbine	1	D



B. THERMAL SCIENCES

I. Steam Engineering:

<u>Item</u>	<u>Nos.</u>	<u>Category</u>
1. Fire tube oil fired boiler working at 15 kgf/cm ² abs. pressure, 700 kg/hr capacity; oil firing equipment, complete with fuel pump and injector, superheaters with water treatment plant and instrumentation.	1	A
2. Experimental steam turbine 15 B.H.P., steam pressure 14-15 kgf/cm ² abs, complete with condensing plant and directly coupled to a hydraulic dynamometer. Fully instrumented.	1	A
3. Steam traps & separators	3	A
4. Separating and throttling calorimeter	2	A
5. Pipe and pipe fittings for gas water and steam supply		A
6. Convergent - divergent steam nozzle testing apparatus	1	A
7. Hand pump and boiler accessories	As required	A
8. Miscellaneous hand tools	As required	A
9. <u>Models:</u>		
i) Steam Engine with D slide valve	2	A
ii) Steam turbines, impulse, reaction Ljungstrom etc.	4	A
iii) Models of steam boilers, water tube, Locomotive	2	A
iv) Boiler accessories .. second hand safety valve lever, feed valve etc.	as required	A

II. I.C. Engines:

<u>Item</u>	<u>Nos.</u>	<u>Category</u>
1. Single cylinder - vertical four stroke Diesel Engine 10 H.P., 1000-1500 r.p.m. coupled to Electric dynamometer.	1	A
2. Two stroke-single cylinder-vertical engine 10 H.P., fitted with pulley and rope brake	1	A
3. Petrol Engine - 4 cylinder - coupled to a hydraulic dynamometer	1	A
4. Single cylinder, four stroke S.I. engine coupled to the generator.	1	A

5. Multi-fuel engine of the Shaktiman truck type	1	A
6. Piezoelectric pressure pick up	1	B
7. Stroboscope	2	A
8. Instruments such as, air flow meters, Tachometers, speed counters, stop watches, thermometers, thermocouples, millivoltmeters, anemometers, planimeters etc.	Lump sum	A
9. Tool kits and crane etc.	As required	A
10. Centrifugal pump, 30 ft. head with 10 H.P. motor, also tanks.	1	A
11. Supercharger of the rotary or C.F. type	1	A
12. Cathode Ray Oscilloscope (Dual beam)	1	A
13. Injector testing equipment	1	A
14. Air Compressor: Two stage reciprocating 7kgf/cm ² 3 m ³ /min, coupled to electric motor dynamometer type, energy meter, air bottles, air-flow meters etc.	1	A
15. Models:		
i) Two stroke petrol engine	1	A
ii) Four stroke petrol engine	1	A
iii) Diesel Engine	1	A
iv) I.C. Engine components such as : second hand pistons, connecting rods, governors, crank shafts, valves, camshafts, carburetors, fuel pumps, lubrication pump, radiators.	As required	A
III. <u>Refrigeration and Air-Conditioning:</u>		
1. Apparatus to determine the flow of refrigerants through various types of throttling valves.	1	D
2. Refrigerating vapour - compression machine (charged with any refrigerant) with a labelled diagram to demonstrate the relative position of the various parts and the controls used in the circuit.	1	A

3. Refrigerating vapour - compression machine (of about 1-2 ton refrigeration capacity) with arrangements to measure the flow of the refrigerant, power input to the compressor motor pressures and temp. at various points, flow of water and rise in temperature in the condenser, the rise in temperature and the flow of brine and rise in temperature in the evaporator.	1	A
4. Charging equipment for refrigerators, complete with pressure gauges etc.	1	A
5. Automatic - control devices of various types, high pressure - low pressure cutouts, capacity controls, solenoid valves, various types of expansion valves, humidostats and thermostats etc. (from salvage/stock)	Lump Sum	A
6. Measuring instruments, like pressure gauges, thermometers of different temp. ranges, thermocouples (with galvanometers and potentiometers etc.).	Lump sum	A
7. Small $\frac{1}{2}$ H.P. compressors of different types, such as, reciprocating, centrifugal and gear type.	3	A
8. Apparatus to study the performance of air-conditioners and room coolers.	1	A
<u>IV. Fuels and combustion:</u>		
1. Bomb calorimeter	1	A
2. Gas calorimeter	1	A
3. Electric hot wire oven with temperature control	1	A
4. Apparatus for proximate analysis using silica crucibles, analytical balance with weight box and Desiccator	4	A
5. Closed cup-flash point apparatus (Pensky-Martin)	1	A
6. Standard distillation test apparatus for petroleum oils.	1	A
7. Reid vapour pressure apparatus	1	A
8. Aniline point apparatus	1	A
9. Orsat's Gas apparatus (Four bulb type)	1	A
10. Redwood viscometers; No.1	1	A
No.2	1	A
11. Open flash point apparatus	1	A

12. Smoke meter	1	D
13. Flame stabilization (by bluff body equipment)	1	D
14. Bunsen burner method of determining flame velocity	1	A

V. Heat Transfer

1. Apparatus for measuring thermal conductivity of a rod.	1	D
2. Apparatus for measuring thermal conductivity of insulating sheets (Cork, asbestos etc.)	1	D
3. Apparatus for studying phenomena of boiling and condensation.	1	D
4. Muffle furnace (electrical) for temperature upto 1000°C with control.	1	A
5. Radiation pyrometer	1	C
6. Optical pyrometer	1	C
7. Electric hot plate	2	A
8. Immersion heaters	4	A
9. Small capacity air blower	2	A
10. Small capacity water pumps	2	A
11. Auto transformers (2KVA)	4	A
12. Chemical balance	1	A
13. Co-axial two pipe system of a heat exchanger for the following combinations:		
a) Liquid and liquid	}	1 A
b) Steam and liquid		
c) Steam and air		
d) Air and air		
e) Water and air		
14. A multi pass-liquid-liquid tube and shell heat exchanger (with a provision to change the number of passes)	1	D
15. An apparatus to study the fin effectiveness in cooling of surfaces.	1	D
16. Set up for determining the thermal conductivity using conducting paper	1	D
17. Instruments-Anometers, voltmeters, wattmeters Air flow-meters, thermometers, thermo couples etc.	Lump sum	A

VI. Basic thermodynamics & Direct energy conversion:

- | | | |
|--|--------|---|
| 1. Apparatus for measuring specific heat of air and gas constant of air. | 1 each | D |
| 2. Apparatus to determine the pressure - temperature relationship of various pure substances (Mercets' Boiler). | 1 | D |
| 3. Apparatus to illustrate Joule- Thompson effect. | 1 | D |
| 4. Equipment to allow the temperature to be measured by the following methods:
a) Gas temperature by a thermocouple
b) Gas temperature by a pyrometer.
c) Liquid temperature by a mercury in glass thermometer.
d) Bimetal temperature gauge | 1 each | D |
| 5. Equipment to allow the pressure to be measured by the following methods.
a) Inclined manometer for low pressures.
b) Pressure gauges: Their calibration by a dead weight tester.
c) Differential pressure manometer.
d) Vacuum by a U tube manometer. | 1 each | D |
| 6. Adiabatic charging and evacuation apparatus | 1 | D |
| 7. Flat plate solar heat collector | 1 | D |

C. WORKSHOP TRAINING AND PRODUCTION ENGINEERING

I. Carpentry and Pattern makings

<u>Item</u>	<u>Nos.</u>	<u>Category</u>
1. Work Benches 3' x 6' with carpenter's vice (for 2 students)	16	A
2. Wood turning lathe	3	A
3. Wet stone grinder	1	A
4. Circular saw (tilting arbour 12" blade)	1	A
5. Band Saw	1	A
6. Wood work surfacing planer	1	A
7. Thickness planer	1	A
8. Portable sander	1	A
9. Circular saw grinder	1	A
10. Assorted tools for instructors and for instructional purpose.	1 set	A
11. Standard tool kit for students	32 sets	A

II. Smithy:

1. Blacksmith forge (complete with blowers)	10	A
2. W.I. Anvils	10	A
3. C.I. swage blocks with stands (18" x 18")	4	A
4. Sludge Hammer, flatters, fullers, top and bottom swages, punches, tongs.	10 sets	A
5. Staple vice and table	2	A
6. Power Hammer 10wt. capacity	1	A
7. Dust collector	1	A
8. Cropping press (10 tons)	1	A
9. Spring Hammer	1	A
10. Unit forge for item 9	1	A

III. Fittings:

1. Work benches with fitters' vice (2 students per bench)	16	A
2. Marking off table with stand (3' x 4' and 2' x 2')	1 of each size	A
3. Surface plate (2' x 2')	3	A

4. Double wheel tool grinder	1	A
5. Bench drilling machine upto $\frac{1}{2}$ " complete with starter and motor.	1	A
6. Pillar drilling machine upto 1" complete with motor and starter	1	A
7. Assorted tools such as: micrometers, vernier calipers, dial gages (with stand), dial gage with magnetic base and with stand, V blocks, marking blocks, steel rules, spirit level, angle plate (10"x10")	1 set	A
8. Height gauge (300)	1	A
9. Tool kit for students	30 sets	A
10. Special tool kit for instructors.	1 set	A

IV. Industrial Engineering:

1. 8 mm. movie projector with variable speed with accessories.	1	C
2. 8 mm. movie camera	1	C
3. 8 mm. movie reels	As required	C
4. Stop watches (read 1/100 min.)	2	A
5. Slide projector	1	A

V. Welding:

1. Electric Welding Transformer	1	A
2. Electric Welding motor generator set	1	A
3. Electric welder's tool kit	3	A
4. Oxy-Acetylene welding plant low/high pressure	1	A
5. Standard kit for gas welding/cutting	1	A
6. Brazing and soldering equipment	1 set	A
7. Portable grinder	1	A
8. Fitter bench with vices	1	A
9. Safety equipment	1	A
10. Welding tables and stands	1	A
11. Butt welder	1	A
12. Spot welding	1	A

VI. Foundry:

1. Cupola with-blower 1-2 tons	1	A
2. Pit furnace	1	A
3. Sand sieve set	1	A
4. Crucibles of different sizes	1	A
5. Core baking oven	1	A
6. Moulding boxes	60 sets	A
7. Oil fired tilting furnace 100 lb. capacity	1	A
8. Temperature indicating instruments	1	A
9. Portable grinder	1	A
10. Ladles of assorted sizes	6	A
11. Tool kits	32	A
12. Platform weighing scale	1	A
13. Weighing balance	1	A
14. Sand testing equipment		
Permeability tester	1	A
Universal Testing machine	1	A
Moisture testing meter	1	A
Laboratory mixer	1	A
Core shooter ($\frac{1}{8}$ -2")	1	C



VII. Sheet Metals:

1. Shear	1	A
2. Folding and Bending machine (Hand operated)	1	A
3. Circle-cutting machine 18" (Hand operated)	1	A
4. Tin, copper sheet metal worker tools	1	A
5. 25 ton crank press	1	A
6. Screw press	1	A

VIII. Metrology:

1. Micrometer		
(a) Outside 0 - 25 mm	3	A
25 - 50 mm.	2	A
25 -150 mm. (combination set)	1	A
(b) Internal 12-25 mm.	1	A
25-100 mm. (with attachments)	1	A

2. Vernier callipers 0-150 mm. with depth gauge attachments.	2	A
3. Dial test indicator 0.01 mm. 0.002 mm.	3 1	A A
4. Vernier protractor	2	A
5. Micrometer depth gauge 0 -25 mm. with rod attachments.	2	A
6. Taper gauge (inside and outside)	1 each	A
7. Plug and Ring gauge	1 each	A
8. Screw and Ring gauge	1 each	A
9. Radius gauge	1	A
10. Feeler gauge 1 -15	1	A
11. Sine bar 250 mm., 500 mm.	1 each	A
12. Parallels 150 mm., 300 mm.	4 each	A
13. Surface plates 300 x 450 workshop standard 450 x 600 Inspection	3 1	A A
14. Slip gauge workshop standard, reference	1 each	A
15. Accessories for block gauges	1 set	A
16. Height gauge 300	1	A
17. Angle gauge blocks	1 set	A
18. Standard pairs of rollers and spherical balls of sizes 5-25 mm.	1 set each	A
19. Gear tangent callipers	1	A
20. Gear tooth verrier	1	A
21. Bench Centre 180 mm., 200 mm.	1 each	A
22. Straight edges 450 mm., 600 mm.	1 each	A
23. Pneumatic comparators solar type with standard plugs and accessories.	1	D
24. Profilometer r.m.s. or CLA	1	C
25. Pitch measuring machine with standard accessories, rollers (needles) and prisms	1	

26. Electrical or optical comparator	1	C
27. Tool makers microscope	1	C
28. Auto collimeter with two-directional reading and accessories	1	C
29. Precision spirit levels accuracy 10 seconds	1	C
30. Compound sine table	1	C
31. Bore gauges 2- 10 mm.	1	C
32. Precision dilatometer	1	C
33. Involute gear tester	1	C
34. Monochromatic light source	1	C
35. Optical flat with precision /10, diameter 60 mm.	4	C

IX. Machine shops:

1. S.S. and S.Q. Lathes 6 $\frac{1}{2}$ " (160 mm.), 1000 mm. centre distance alongwith driving motors, accessories like true chucks, face plates etc., Grade A.	12	A
2. Shaping machine 300 stroke with driving motors, starters etc.	2	A
3. Shaping machine 600 stroke with motor, stor	1	A
4. Universal milling machine with motor and starter, with dividing head Table size 1100 x 275 mm. capacity 550 x 225 x 365 mm.	1	A
5. Universal cutter and tool grinder No.2, motorized with universal vice and other accessories.	1	A
6. Universal cylindrical grinding machine 130 x 620 mm.	1	A
7. Pillar drilling machine 25 mm. capacity	1	A
8. Radial drilling machine 3 $\frac{1}{2}$ mm.	1	A
9. Wet and dry tool grinder 250 mm.	1	A
10. Carbide tool grinder 25 $\frac{1}{2}$ mm.	1	A
11. Power hacksaw	1	A
12. Marking off table 900 x 1200 mm.	1	A

13. Surface plates 600 x 600 mm.	1	A
14. High speed precision lathe H 22 (HMT), size 225 x 1000 mm. with hydraulic copying attachments.	1	A
15. Tools and instruments; cutters, drills, taps, reamers, dies, drill chucks, micrometers, dial gauge with stand and magnetic base, vernier callipers, scales etc.	As required	A
16. Hand tools, Files (various sizes and grades), hammer, centre punch etc.	As required	A
17. Lathe tools; H.S.S. tools, carbide, through away bit tools including carbide and oxide bits.	As required	A
18. Slotting machine	1	A
19. Machine tool testing accessories	-	A
20. Dynamometers Lathe, 3 component - 340 kg. Drilling machine, torque and vertical	-	D
21. Analytical balance	1	A
22. Surface grinding machine 225x600 mm.	1	A
23. Tachometer 0-50,000 rpm.	1	C
24. Turret lathe 200 mm. bar capacity	1	A
25. Stop watches	2.	A
26. Vertical milling machine table 1100x275 mm.	1	A
27. Stroboscope with oscillator etc.	1	A
28. 3 channel d.c. amplifier alongwith strain bridge	1	A,1
29. Oscilloscope (dual beam)	1	A
30. Camera attachment for item 29	1	C
31. D.C. Power supply unit	1	A
32. Pickups for load, vibration etc.	1 each	D
33. Single spindle automatic lathe.	1	A

DESIGN AND SYNTHESIS

I. Dynamics:

<u>I t e m</u>	<u>Nos.</u>	<u>Category</u>
1. Apparatus for dynamic analysis of cams and followers	1	D
2. Dynamic balancing apparatus for rotary masses	1	A
3. Static balancing apparatus	1	A
4. Dynamic balancing apparatus for reciprocating masses	1	D
5. Whirling of shaft apparatus	1	A
6. Gyroscope - motorised	1	A
7. Torsional oscillation apparatus	1	D
8. Belt transmission apparatus	1	D
9. Cone and collar friction apparatus	1	B
10. Kinematic friction apparatus	1	B
11. Trifilar suspension	1	B
12. Shake table for calibration of vibration instruments	1	D
13. Dashpot calibration apparatus	1	D
14. Electrical Analogy Kit	1	D
15. Apparatus for generating involute tooth profile	1	B
16. Coriolis acceleration set-up	1	D
17. Set-up for finding efficiency of geared systems	1	D
18. Vibrating rod apparatus for finding co-efficient of friction	1	D

19. Vibration machine with arrangement for free and forced damped and undamped vibrations, excited by unbalanced mass with arrangement for amplitude and phase measurement (single degree of freedom)	1	D
20. Journal friction apparatus	1	D
21. Beam vibration apparatus with provision for dynamic vibration absorber	1	D
22. Electromagnetic exciter (15 lb. thrust) with variable frequency oscillator	1	C
23. Desk calculator	1	C
24. Instruments:		
i) Vibration pick-ups of various types	3	C, D.
ii) Seismic Vibrometer	1	B
iii) Seismic Accelerometer	1	D
iv) Audio Oscillator	1	A, C.
v) Power Amplifier	1	A, C.
vi) Stroboscope with frequency calibration unit	1	A
vii) Dual beam oscilloscope	1	A
viii) High speed recording camera for oscillo-scope	1	C
ix) Variable inductance transducer with amplifier	1	A, D.
x) Vibrograph	1	C
25. Assorted Instruments: Tachometer, stopwatch, dial gauge, AVO meter, vernier and micrometer calipers	-	A
26. Variable speed electric motors	4	A
27. Hand tools	-	

28. Models: Linkage mechanisms, with inversions of single and double slider crank mechanisms; pantograph; valve gears; epicyclic gear trains; bevel gear trains; differential gears; universal joints; governors; clutches; brakes of various types; mechanisms used in typewriters, sewing machines and mechanical computers; mechanical and electrical models of vibration and shock absorbers.

II. INSTRUMENTS AND CONTROLS:

- | | | |
|---|---------------------------|-------|
| 1. Double beam oscilloscope | 1 | A |
| 2. Strain gauge bridge with amplifier and assorted types of bonded strain gauges | 1 | C, D. |
| 3. Thermocouples, thermocouples amplifier | 1 | A |
| 4. Pressure transducers of capacitance, piezoelectric and strain gauge types with necessary amplifier and readout system | One of each A, C, D. type | |
| 5. VTVM | 1 | A |
| 6. Accelerometers and Cathode follower | 1 | C |
| 7. Differential Transformers | 4 | D |
| 8. Load Cells | 2 | C, D. |
| 9. Photocells | 2 | A |
| 10. Apparatus for frequency response and stability Studies on servo-systems | 1 | C |
| 11. Set-ups to demonstrate the response of first and second order systems by hydraulic pneumatic and mechanical means | - | D |
| 12. Apparatus for studying mechanical and hydraulic feed back systems | - | D |
| 13. Process Control Stimulator Equipment | 1 | C |
| 14. Assorted electrical and electronic components - variable speed motors, power supply, batteries, Potentiometers, Battery chargers, Capacitors, Resistors, etc. | As required | A |

15.	Assorted instruments for measuring length and area: metre scales, vernier and micrometer calipers, dial gauges, ordinary and polar planimeters.	As required	A
16.	Assorted instruments such as: Stop watches, electrical and mechanical timers, tachometers, strain gauge torquemeter, elastic torsion bar, prony brake, hydraulic dynamometer	One of each	A, D.
17.	Models of temperature and pressure controllers	-	A
18.	Models of various logic devices with limit switches relays, pneumatic valves etc.	-	C, D.
19.	Analogy computer or analogy circuits to demonstrate addition, subtraction, multiplication, division etc.	1	A, B
20.	Assorted hand tools, soldering iron, solder and flux, connecting wire etc.	As required	A

III. General Mechanics

1.	A' wood Machine	1	A, B.
2.	Fletcher's Trolley	-	-
3.	Simple Pendulum	1	B
4.	Compound Pendulum	1	B
5.	Moment of inertia of flywheel apparatus	1	B
6.	Young Modulus apparatus	1	A
7.	Strut testing apparatus	1	A
8.	Assorted models: differential wheel and axle, single and double purchase crabs, worm and worm wheel, screw jack, pulley block, geared pulley block western's differential pulley block	-	A, B.

9	Assorted instruments meter rules, weights of different sizes, stop watches, dial gauges, vernier and micrometer calipers etc.	-	A
10.	Variable Speed motors	4	A
11.	Assorted hand tools	-	A

IV. Material Testing

1.	Universal Testing Machine 10 tons (or above) capacity with shear tools, autographic recorder etc.	1	C
2.	Creep testing machine	1	C
3.	Extensometers - mechanical, optical and electrical	3	C
4.	Hardness testing machine - Vickers and Brinell	One of each type	C
5.	Reversible torsion testing machine 2000 in./lb. capacity	1	A
6.	Impact testing machine, Izod and Charpy combined 120 in./lb. capacity	1	C
7	Fatigue testing machine	1	C
8	Apparatus for testing torsional rigidity of wires	1	A
9.	Universal Tensometer with autographic recorder and standard accessories - 2 ton capacity	1	C
10.	Calibrated proving ring	1	C
11.	Deflectometers	1	C
12.	Oethotometer (travelling telescope)	1	A
13.	Universal wood testing machine maximum capacity 100 kg complete with standard accessories	1	C
14.	Assorted instruments: micrometer and vernier calipers, dial gauges etc.		A
15.	Assorted hand tools	As required.	A

V. Experimental Stress Analysis

1. Strain gauge equipment bonded wire electrical resistance type with 2 strain indicators, switching and balancing unit, calibration check unit, different type of strain gauges and other accessories	1	C, D.
2. Equipment for measurement of dynamic strain in conjunction with the bonded wire electrical resistance type strain gauges, with magnetic oscillograph, control unit, calibration box and other accessories and spares	1	C
3. Acoustic strain gauges	-	C
4. Photoelastic bench with a box camera and other accessories	1	C, D.
5. Assorted electrical and electronic components: soldering iron, solder and flux, connecting wire etc.	As required.	A
6. Hand Tools	As required.	A

VI. Material Science:

1. Potentiometer set	1	A
2. Conductivity Bridge	1	A
3. Terrohmeter	1	C
4. Hardometer	1	C
5. Heat Treatment furnace	1	A
6. Creep testing machine (the one in Material Testing Laboratory may be used instead of a separate unit)	1	C
7. Tensiometer with muffle and controls	1	C
8. Thermocouple wire and potentiometer	1	A
9. Temperature recorder	1	A

10. X-Y plotter	1	A
11. Crystal growing equipment for lead, zinc and aluminium	1	A
12. Microscopes	3	A
13. Mounting press	1	A
14. Polishing machine	1	A
15. Electro polisher	1	A
16. Hand tools	As required.	A

